PB-229 579

PROCEEDINGS. CONFERENCE IN THE MATTER OF POLLUTION OF THE NAVIGABLE WATERS OF BISCAYNE BAY AND ITS TRIBUTARIES IN THE STATE OF FLORIDA HELD AT MIAMI, FLORIDA, FEBRUARY 24, 25, 26, 1970

Federal Water Pollution Control Administration
Washington, D.C.

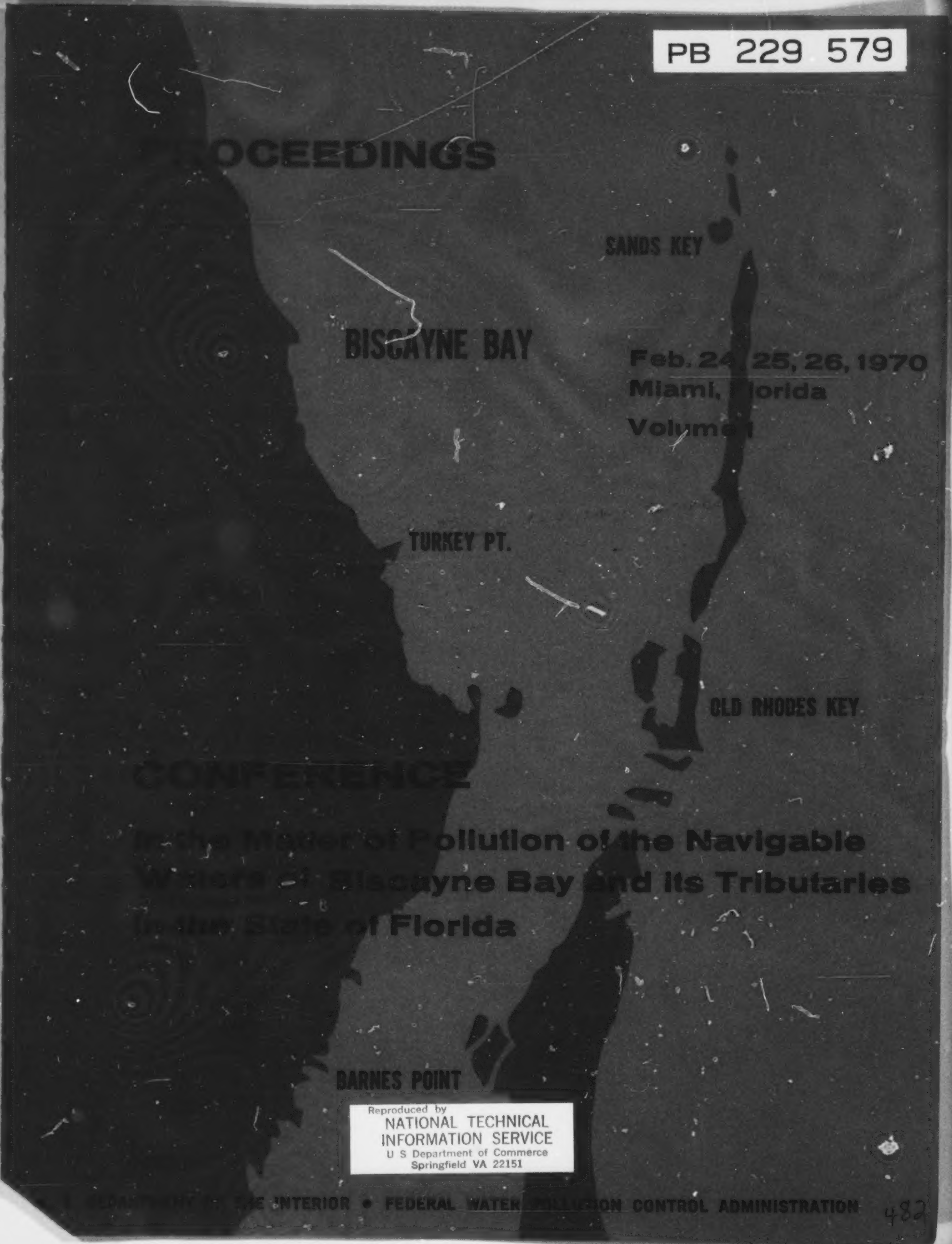
26 February 1970

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 229 579

PROCEEDINGS


SANDS KEY
BISCAYNE BAY
TURKEY PT.
OLD RHODES KEY
BARNES POINT

Feb. 24, 25, 26, 1970
Miami, Florida
Volume 1

CONFERENCE

In the Matter of Pollution of the Navigable Waters of Biscayne Bay and its Tributaries in the State of Florida

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

U. S. DEPARTMENT OF THE INTERIOR • FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

482

DEPARTMENT OF THE INTERIOR

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

CONFERENCE

IN THE MATTER OF POLLUTION OF THE NAVIGABLE WATERS OF BISCAYNE BAY AND ITS TRIBUTARIES IN THE STATE OF FLORIDA

The Four Ambassadors Hotel
801 South Bayshore Drive
Miami, Florida
Tuesday, February 24, 1970

Convened, pursuant to notice, at 9:30 a.m.

PRESIDING:

Murray Stein	Assistant Commissioner for Enforcement and Standards Compliance, Federal Water Quality Administration U. S. Department of the Interior, Washington, D. C.

CONFEREES:

John Thoman	Director, Southeast Region, Federal Water Pollution Control Administration, Atlanta, Georgia
Nathaniel Reed	Chairman, Florida Department of Air and Water Pollution Control, Tallahassee, Florida
Vincent Patton	Executive Director, Florida Department of Air and Water Pollution Control, Tallahassee, Florida

INDEX

WITNESS	PAGE
The Honorable Walter J. Hickel (read by Murray Stein)	1
Opening Statement by Murray Stein	1
The Honorable Claude R. Kirk, Jr. (read by Nathaniel Reed)	9
John Hagan	11
Lee Purkerson	218
Dr. Clarence M. Tarzwell	264
John C. Raftery	304
R. T. Whiteleather (read by Dr. Carl J. Sindermann)	313
Colonel A. S. Fullerton	316
Vincent D. Patton	328
Paul W. Leach	369
Colonel A. M. Davis	385
William C. Steel	429

FEDERAL SPEAKERS

Colonel A. S. Fullerton
District Engineer
Jacksonville District
U. S. Army Corps of Engineers
400 W. Bay Street
Jacksonville, Florida

John E. Hagan
Federal Water Pollution Control Administration
Lower Florida Estuary Project
Post Office Drawer EEE
Hollywood, Florida 33022

Lee Purkerson
Federal Water Pollution Control Administration
2600 South Bayshore Drive
Miami, Florida 33133

John C. Raftery
Superintendent
Everglades-Biscayne
National Park Service
Everglades National Park
Homestead, Florida 33030

Dr. Carl Sindermann
Laboratory Director
U. S. Bureau of Commercial Fisheries
St. Petersburg, Florida

Clarence M. Tarzwell
Director
National Marine Water Quality Laboratory
Federal Water Pollution Control Administration
Box 577
West Kingston, Rhode Island 02892

FLORIDA SPEAKERS

Gene Autrey
Vice President
Florida Power and Light Company
4200 West Flagler
Miami, Florida

B. J. Chapman
Professional Engineer
Dade County Pollution Control Hearing Board
2731 Ponce de Leon Blvd.
Coral Gables, Florida 33134

Dr. Robert Dean
Chairman
College of Engineering
University of Florida
Gainesville, Florida

Robert G. Dean
Professor
University of Florida
1320 N. W. 30th Street
Gainesville, Florida 32601

Dr. Donald P. de Sylva
Associate Professor of Marine Science
University of Miami
1 Rickenbacker Causeway
Miami, Florida 33149

Thomas B. DeWolf
Attorney
Seadade Industries
600 Brickell Avenue
Miami, Florida 33131

Gordon E. Dunn
Florida Power and Light Company
5111 Alhambra Circle
Coral Gables, Florida 33146

FLORIDA SPEAKERS con't

Jean Evoy
Tropical Audubon Society
5930 S. W. 80th Street
South Miami, Florida 33143

Dr. Werner N. Grune
Professor and Consultant
University of Miami
1219 Manati Avenue
Coral Gables, Florida 33134

Dr. Gordon Gunter
Director, Gulf Coast
Research Laboratory
Florida Power and Light Company
Ocean Springs, Mississippi 39564

C. L. Hosler
Dean
Penn State University
Seadade
600 Brickel Avenue
Miami, Florida

Henry A. Kauffmann
Dade Citizens for Clean Water
5750 S. W. 56th Terrace
S. Miami, Florida 33143

James B. Lackey
Consultant
Florida Power and Light Company
Box 36
Melrose, Florida 32666

Paul W. Leach
Director
Dade County Pollution Control
864 N. W. 23rd Street
Miami, Florida 33127

Gerald A. Lewis
Attorney
Lewis & Reno
719 City National Bank Building
Miami, Florida 33130

Ray L. Lyerly
Senior Associate
Southern Nuclear Engineering Inc.
P. O. Box 10
Dunedin, Florida 33528

FLORIDA SPEAKERS con't

Jack O'Quinn
Consultant
Seadade
Four Ambassadors
S-1711
Miami, Florida

George L. Patterson
Attorney
Florida Power and Light
1400 First National Bank Building
Miami, Florida

I. E. Perry
Bel Aire Women's Club
9772 S. W. 190 Street
Miami, Florida

Senator Ralph Poston
State Senator
Miami, Florida

William F. Ragan
Attorney
Seadade
Farragut Building
Washington, D. C.

James F. Redford, Jr.
President
Mangrove Chapter
Izaak Walton League
2829 Bird Avenue
Miami, Florida 33133

Herbert S. Riesbol
Engineering Manager, Hydrology
Bechtel Incorporated
50 Beale Street
San Francisco, California

Dr. Martin A. Roessler
Assistant Professor
School Marine & Atmospheric Sciences
10 Rickenbacker Causeway
Miami, Florida 33149

Dr. Robert A. Stevenson
Assistant Professor
Institute of Marine Sciences
University of Miami
1 Rickenbacker Causeway
Miami, Florida

FLORIDA SPEAKERS con't

Tod Sqalm
Manager
Homestead Chamber of Commerce
Homestead, Florida

Dr. Gilbert Voss
7393 S. W. 79th Court
Miami, Florida 33140

Mrs. John Wainwright
President
Tropical Audubon Society
3480 Main Highway
Miami, Florida 33133

Charles B. Wurtz
Associate Professor
Florida Power and Light Company
La Salle College
Philadelphia, Pa. 39141

Colonel A. M. Davis
Vice President
Florida Power and Light Company
Miami, Florida

Peter M. Phelps
Consultant
Seadade Industries, Incorporated
Kentfield, California

Herbert W. Hoover, Jr.
Chairman
Hoover Environmental Legal
Defense Fund
Bal Horbour, Florida

OTHERS IN ATTENDANCE

Valdas V. Adamkus
Special Assistant to
the Commissioner
Federal Water Pollution
Control Administration
U. S. Department of the
Interior
Washington, D. C. 20242

Bjarne B. B. Anderson, Jr.
Assist Attorney General
Office of the Attorney General
The Capitol
Tallahassee, Florida 32313

J. W. Babb
Town Planning Student
Box 2537 AMF
Miami, Florida 33159

Richard G. Bader
School of Marine Sciences
University of Miami
10 Richenbacker Causeway
Miami, Florida

Linda Bair
Student (Miami-Dade Jr.
College)
45 W. 35th Street
Hialeah, Florida 33012

Anne Baxter
Research Librarian
Center for Urban Studies
Univeristy of Miami
Miami, Florida

Miss Jeanne Bellamy
Sr. Editorial Writer
Miami Herald
1 Herald Plaza
Miami, Florida 33101

Larry Bogart
Director
Anti-Pollution League
Allendale, New Jersey 07401

James R. Brindell
Attorney
Ocean Law Program
University of Miami School of Law
8107 S. W. 72nd Avenue
Apt. 421-E
Miami, Florida 33143

Thomas J. Buchanan
Subdistrict Chief
U. S. Geological Survey
51 S. W. 1st Avenue
Miami, Florida 33130

Clara E. Buck
South Florida Garden Club
4921 Ponce de Leon
Coral Gables, Florida 33146

J. E. Burgess
Fishery Biologist
U. S. Fish & Wildlife
1031 Miracle Mile
Vero Beach, Florida 32960

Arthur Calvert
Miami Regional Official
Florida Department of Agriculture
Miami, Florida

Joseph D. Carroll
Acting Field Supervisor
Bureau of Sport Fisheries
and Wildlife
1031 Mircle Mile
Vero Beach, Florida 32960

Louie Coggins
Executive Director
National Electrical Contractors
Association
Miami, Florida

Leslie F. Conover
Consulting Meteorologist
Seadade
600 Brickell
Miami, Florida

George Cooper, Jr.
Grower-Owner
Cooper Farms
Perrine, Florida

OTHERS IN ATTENDANCE con't

Paul W. Cordsmeyer
12435 S. W. 187 Street
South Miami, Florida 33157

Dr. James Coughlin
Vice-President
Florida Power & Light Company
P. O. Box 3100
Miami, Florida 33101

Gary D. Craven
News Photographer
Channel 10-WLVW-TV
3900 Biscayne Blvd.
Miami, Florida

Mrs. Edwin Dean
Executive Committee
Florida Federation of Garden Clubs
Miami, Florida

Robert G. Dean
Chairman, Department of Coastal
and Oceanographic Engineering
University of Florida
1320 N. W. 30 Street
Gainesville, Florida 32601

Sergio De La Vega
Sales Manager
Covela Trading, Inc.
5767 S. W. 8th Street
Miami, Florida 33144

Joseph T. Derry
"Survive"
13 S. Royal Poinciana Blvd.
Miami Springs, Florida 33166

Jack M. Dunn
Sales Engineer
GELO
2106 S. Lois Avenue
Tampa, Florida 33609

Ingrid Dykes
I Vice President
Bel-Aire Woman's Club
9762 S. W. 190th Street
Miami, Florida 33157

Thomas F. Engelhardt
Attorney
U. S. Atomic Energy Commission
Washington, D. C. 20545

W. Arthur Fielden
3361 S. W. 3rd Avenue
Miami, Florida 33145

Ronald L. Fine
President
Venture Development Corporation
1212 City National Bank Building
Miami, Florida 33130

W. E. Fisher, Jr.
Seadade Industries, Inc.
1345 6th Avenue
New York, New York

Albert Fontela
President
Covela Trading, Inc.
5767 S. W. 8th Street
Miami, Florida 33144

W. E. Fulford
State Representative
Sub-Committee Air & Water Pollution
P. O. Box 1226
Orlando, Florida 32802

John J. Gall, Jr.
Graduate Student
University of Miami
1219 Manati Avenue
Coral Gables, Florida

Thomas P. Gallagher
Federal Water Pollution Control
Administration
Southeast Water Laboratory
College Station Road
Athens, Georgia 30601

R. J. Gardner
Executive Assistant
Florida Power and Light Company
P. O. Box 3100
Miami, Florida 33101

Virginia Gentle
Instr. Biologist
Miami-Dade Junior College
11010 S. W. 60 Avenue
Miami, Florida 33156

OTHERS IN ATTENDANCE con't

Edward J. Glendening
Benham-Blair & Affiliates
1040 Bayview Building
Fort Lauderdale, Florida

Mrs. H. T. Gadwin
Biltmore Heights Garden Club
932 Escobar Avenue
Coral Gables, Florida 33134

Ernest Goitein
Project Engineer
Bechtel Corporation
P. O. Box 3965
San Francisco, California 94119

Carole Golden
Student
Miami-Dade Junior College
480 E. 41st Street
Hialeah, Florida 33013

Robert S. Gordon
Binham-Blair & Associates
1040 Bayour Building
Fort Lauderdale, Florida 33304

William M. Greenslade
Hydrogeologist
Dames & Moore
1314 W. Peachtree Street, N. W.
Atlanta, Georgia 30309

Julia L. Gunnels
Research Assistant
Survive
5000 Hammock Drive
Miami, Florida

Orville W. Haller
President
Homestead Chamber of Commerce
Homstead, Florida

Donald V. Hansen
Director, Physical Oceanography Laboratory
Atlantic Oceanographic & Meteorological Laboratories, ESSA
901 S. Miami Avenue
Miami, Florida 33130

Mrs. Gordon E. Hartway
President
Bel-Aire Woman's Club
9940 S. W. 194th Street
Miami, Florida 33157

James H. Hartwell
Hydrologist
U. S. Geological Survey
51 S. W. 1st Avenue
Room 730
Miami, Florida 33130

J. D. Hicks
Vice President, Operations
Tampa Electric Company
111 No Dale Mabry
Tampa, Florida 33601

Ron Higgins
Hoover Environmental Legal Defense Fund, Inc.
799 Galrano
Coral Gables, Florida 33134

Bill Hoffman
Scout Executive
Boy Scouts of America
South Florida Council
Miami, Florida

Dr. Robert L. Holton
Marine Biologist
Atomic Energy Commission
Washington, D. C. 20545

Mrs. Paul E. Hoy
Charter President
Bel-Aire Woman's Club
9840 S. W. 194th Street
Miami, Florida

Dr. C. P. Idyll
Professor
University of Miami
Institute of Marine Sciences
1 Rickenbacker Causeway
Miami, Florida

R. M. Ingle
Department of Natural Resources
Tallahassee, Florida 32304

OTHERS IN ATTENDANCE con't

Edwin S. Iversen
Associate Professor
University of Miami
427 Majoria
Coral Gables, Florida 33134

George N. Jahw
Attorney
Henry Rexact
800 Seybold Building
Miami, Florida 33132

David V. Jenrette
Assistant Professor
Miami-Dade Junior College
10050 S. W. 63rd Place
Miami, Florida 33156

Bruce Johnson
Executive Director
Florida Commission on Marine Sciences
615 S. W. 2nd Avenue
Miami, Florida 33131

Alex Kaiser
Assistant General Manager,
Production
Tampa Electric Company
P. O. Box 111
Tampa, Florida 33601

Matthew Kenny
International Press International

Mr. Carl Klein
Assistant Secretary for Water Quality
and Research
Federal Water Pollution Control
Administration
U. S. Department of the Interior
Washington, D. C. 20242

Mrs. Fred A Klein
Conservation Chairman
Baltimore Heights Garden Club
5851 S. W. 49th Street
Miami, Florida 33155

Richard W. Klukas
Management Biologist
National Park Service
Everglades National Park
P. O. Box 279
Homestead, Florida 33030

Dr. J. B. Koogler
Vice President
Environmental Engineering, Inc.
2324 S. W. 34th Street
Gainesville, Florida 32601

John LaCarda
Assistant to the President
Perry Submarine Builders
Riviera Beach, Florida 33404

Lyle Lamson
President
National Electrical Contractors
Association
Miami, Florida

Saul Lenine
Assistant Director,
Reactor Technology
Atomic Energy Commission
Washington, D. C.

Walter Livingston
1740 S. W. 92nd Court
Miami, Florida 33165

W. Harry Logue
Econ. Development
323 South Britian Street
Shelbyville, Tennessee 37160

R. W. Lowe
Base Engineer
United States Air Force
Homestead Air Force Base, Florida

P. A. "Bill" Lund
Governor's Natural Resources
Committee
Box 541
Jupiter, Florida 33458

A. E. Lyman
Civitan Club
1760 Westward Drive
Miami Springs, Florida 33166

James Malone
Reporter
Miami Herald
Miami, Florida

OTHERS IN ATTENDANCE con't

Edwin S. Iversen
Associate Professor
University of Miami
427 Majoria
Coral Gables, Florida 33134

George N. Jahw
Attorney
Henry Rexact
800 Seybold Building
Miami, Florida 33132

David V. Jenrette
Assistant Professor
Miami-Dade Junior College
10050 S. W. 63rd Place
Miami, Florida 33156

Bruce Johnson
Executive Director
Florida Commission on Marine Sciences
615 S. W. 2nd Avenue
Miami, Florida 33131

Alex Kaiser
Assistant General Manager,
Production
Tampa Electric Company
P. O. Box 111
Tampa, Florida 33601

Matthew Kenny
International Press International

Mr. Carl Klein
Assistant Secretary for Water Quality
and Research
Federal Water Pollution Control
Administration
U. S. Department of the Interior
Washington, D. C. 20242

Mrs. Fred A Klein
Conservation Chairman
Baltimore Heights Garden Club
5851 S. W. 49th Street
Miami, Florida 33155

Richard W. Klukas
Management Biologist
National Park Service
Everglades National Park
P. O. Box 279
Homestead, Florida 33030

Dr. J. B. Koogler
Vice President
Environmental Engineering, Inc.
2324 S. W. 34th Street
Gainesville, Florida 32601

John LaCarda
Assistant to the President
Perry Submarine Builders
Riviera Beach, Florida 33404

Lyle Lamson
President
National Electrical Contractors
Association
Miami, Florida

Saul Lenine
Assistant Director,
Reactor Technology
Atomic Energy Commission
Washington, D. C.

Walter Livingston
1740 S. W. 92nd Court
Miami, Florida 33165

W. Harry Logue
Econ. Development
323 South Britian Street
Shelbyville, Tennessee 37160

R. W. Lowe
Base Engineer
United States Air Force
Homestead Air Force Base, Florida

P. A. "Bill" Lund
Governor's Natural Resources
Committee
Box 541
Jupiter, Florida 33458

A. E. Lyman
Civitan Club
1760 Westward Drive
Miami Springs, Florida 33166

James Malone
Reporter
Miami Herald
Miami, Florida

OTHERS IN ATTENDANCE con't

Jack Maloy
Central & Southern Florida
Flood Control
P. O. Box 1641
West Palm Beach, Florida 33402

Sandra S. Maycork
Student
Miami-Dade Junior College
Miami, Florida

Carl McKenry
Director, Center for Urban Studies
University of Miami
P. O. Box 8002
Coral Gables, Florida 33124

John E. McLean
Sanitary Engineer
Federal Water Pollution Control
Administration
U. S. Department of the Interior
Washington, D. C. 20242

Miss Barbara Moore
Executive Director
Girl Scouts of America
Miami, Florida

Jack F. Moore, Jr.
Reporter
WCKT-TV
1401 79th Street Causeway
Miami, Florida 33138

Penny Morgan
Zoological Society
P. O. Box 492
Coral Gables, Florida 33134

J. H. Motz
Environmental Engineer
Georgia Power Company
P. O. Box 4545
Atlanta, Georgia

William L. Mullett
Senior Mechanical Engineer
Southern Nuclear Engineering
P. O. Box 10
Dunedin, Florida 33528

B. F. Murphy
Project Chemist
2423 White Road
University Heights, Ohio 44118

Dr. Roy E. Nakatani
Research Associate
Atomic Energy Commission
Richland, Washington 99352

Gerhard Neumaier
CAL
Buffalo, New York 14052

Lee Niedlinger
Representative
Plymouth Congregational Church
Miami, Florida

Frank Nix
Hydraulic Engineer
National Park Service
Box 279
Homestead, Florida 33030

Mrs. Mary Oakerson
President
Girls Scouts Council
Miami, Florida

R. E. Parnelle
Environmental Engineer
Florida Power Corporation
P. O. Box 14042
St. Petersburg, Florida 33733

David Parry
Manager
General Electric Company
2106 South Lois Avenue
Tampa, Florida

Linda Perkins
Student
Miami-Dade Junior College
548 East 42nd Street
Hialeah, Florida 33013

Benjamin S. Persons
Partner
Dames and Moore
1314 W. Peachtree Street, N. W.
Atlanta, Georgia 30309

Allen T. Peyton, Jr.
Deputy Director
Southern Interstate Nuclear Board
Suite 664
800 Peachtree Street, N. E.
Atlanta, Georgia 30308

OTHERS IN ATTENDANCE con't

Catharine Pile
Member-Aububon Club
1424 S. W. 23rd Street
Miami, Florida 33145

H. Neal Phelps
Field Director
Boy Scouts of America
2960 Coral Way
Miami, Florida 33145

P. M. Phelps
Consultant
Seadade Industries
15 Buckeye Way
Kentfield, California 94904

Dr. Thomas W. Philbin
Senior Environmental Engineer
S. M. Stoller Corporation
1250 Broadway
New York, New York 11566

Mrs. William B. Pierce
National Audubon
724 Camito Avenue
Coral Gables, Florida 33134

M. V. Polito
Chief Chemist
Lower Florida Estuary Project
Hollywood, Florida 33022

Rear Admiral Paul G. Prins
Commander, Seventh Coast Guard District
U. S. Coast Guard
51 S. W. 1st Avenue
Miami, Florida

Mrs. L. Lee Purkerson
10221 S. W. 103 Court
Miami, Florida 33156

H. D. Putnam
Environmental Engineering, Inc.
2324 S. W. 34th Street
Gainesville, Florida 32601

Frank H. Rainwater
Chief, National Thermal Pollution Research
Federal Water Pollution Control Administration
Corvallis, Oregon

Lavinia L. Redd
Asstiant U. S. Attorney
Department of Justice
300 N. E. 1st Avenue
P. O. Box 1070
Miami, Florida 33101

Polly Redford
IWLA
3975 Little Avenue
Miami, Florida 33133

Dick Renick
State Representative
Florida
7500 Red Road
South Miami, Florida

Janet Reno
719 City National Bank Building
Miami, Florida 33130

William S. Richardson
Professor of Oceanographics
Nova University
1901 S. E. 15th Street
Fort Lauderdale, Florida 33316

William B. Robertson, Jr.
Research Biologist
U. S. National Park Service
Everglades National Park
Homestead, Florida 33030

Mrs. R. W. Robinson
President
Biltmore Heights Garden Club
1033 Andorn
Coral Gables, Florida 33146

Martin Roessler
Assistant Professor
School Marine & Atmospheric Sciences
10 Rickenbacker Causeway
Miami, Florida 33149

Herbert H. Rogers
Chief, Environmental Resources Branch
U. S. Army Corps of Engineers
510 Title Building
30 Pryor Street
Atlanta, Georgia 30311

OTHERS IN ATTENDANCE con't

E. T. Ross
Resident Engineer
U. S. Army Corps of Engineers
P. O. Drawer 59
Miami Beach, Florida 33139

Herbert Saffir
Consulting Engineer
123 Madeira Avenue
Coral Gables, Florida 33134

G. S. Sayles
Agriculture & Conservation Chairman
Southwest Kiwanis
8154 West 75th Street
Miami, Florida 33136

Keith O. Schwab
Director of Technical Programs
Federal Water Pollution Control
Administration
Ohio Basin Region
Room 7027
550 Main Street
Cincinnati, Ohio 45230

Betsy Scott
Student
Miami-Dade Junior College
680 N. E. 2nd Place
Hialeah, Florida 33010

Frank B. Silvestro
Research Physicist
Cornell Aero. Lab.
P. O. Box 235
Buffalo, New York 14221

W. D. Shelnutt
Director
Civitan
701 Oriole Avenue
Miami Springs, Florida 33166

Mrs. M. G. Snedeker
530 S. W. 18th Terrace
Miami, Florida 33129

Norman Sokoloff
700 Biltmore Way
Coral Gables, Florida 33124

Margo A. Stahl
Graduate Student
Institute of Marine Sciences
University of Miami
Virginia Key
Miami, Florida 33124

W. E. Starnes
Chief, Bureau of Surveillance
Florida Department of Air and WAter
Pollution Control
Tallahassee Bank Building
Suite 400
Tallahassee, Florida 32301

William C. Steel
Lawyer
Florida Power & Light Company
1400 1st National Bank Building
Miami, Florida 33131

Louis E. Stone
Manager, Electric Operations
Orlando Utilities Comm.
Box 3193
Orlando, Florida 32802

Jeff Swinebroad
Population Ecologist
U. S. Atomic Energy Commission
Washington, D. C. 20545

John S. Telfair, Jr.
Consulting Engineer to Metro
Dade County on Water & Sewer
Programs
Connell Associates, Inc.
Box 677 -Riverside Station
Miami, Florida 33135

William F. Theobald, Jr.
President
Florida Wildlife Federation
8238 N. E. 9th Avenue
Miami, Florida 33138

Donald E. Thompson
Manager, Thermal Survey Division
MAPCO, Inc.
P. O. Box 1926 - Municipal Airport
Ormond Beach, Florida

OTHERS IN ATTENDANCE con't

Dr. Anitra Thorhaug
Research Scientist
RSMAS
10 Richenbacker Causeway
Miami, Florida 33149

Mr. Paul Traina
Federal Water Pollution Control
Administration
U. S. Department of the Interior
Southeast Water Laboratory
College Station Road
Athens, Georgia 30601

S. D. Vincent
Board Member
Florida Air & Water Pollution
Control Commission
315 S. Calhoun Street
Tallahassee, Florida

Dr. Richard A. Wade
Chief, Bears Bluff Laboratory
Federal Water Pollution Control
Administration
P. O. Box 147
Johns Island, South Carolina 29455

Charles P. Warr
Physicist
U. S. Public Health Service
1012 W. Montgomery Avenue
Rockville, Maryland 20850

Leon W. Weinberger
Vice-President
Zurn Environmental Engineers
2600 Virginia Avenue, N. W.
Washington, D. C. 20037

James P. Wendler
Publisher
Miami Beach Times
Miami, Florida

Jack White
President
Boy Scouts of America
South Florida Council
Miami, Florida

John C. White
Federal Water Pollution Control
Administration
U. S. Department of the Interior
1421 Peachtree Street, N. E.
Suite 300
Atlanta, Georgia 30309

George C. Wilson
National Correspondent
Washington Post
1515 L Street, N. W.
Washington, D. C. 20005

Walter W. Wyatt, P. E.
Chief Engineer
Homestead Air Force Base
Base Civil Engineer's Office
Homestead Air Force Base, Florida
33030

Charles Yentsch
Nova University
Fort Lauderdale, Florida

Robert C. Ziegler
Physicist
Cornell Aeronautical Laboratory
P. O. Box 235
Buffalo, New York 14221

Joseph C. Zieman, Jr.
Institute of Marine Sciences
10 Richenbacker Causeway
Miami, Florida 33149

Opening Statement - Murray Stein

PROCEEDINGS

OPENING STATEMENT
BY
MR. MURRAY STEIN

MR. STEIN: Before the formal jurisdictional opening remarks of the conference, I have this statement to make:

Secretary Walter J. Hickel has directed me to make the following statement: The Federal Government has communicated a number of times with officials of the Florida Power & Light Company regarding its proposed project. The State of Florida has expressed its concern through Governor Kirk's official request for this conference. Now we are meeting together to hear, study and determine what shall be the appropriate State and Federal requirements to protect this special coastal area. Public announcement of this conference was made sometime ago; in fact, on December 11, 1969.

We had expected the officials of the Florida

Power & Light Company to refrain from taking any action which would change the position of the parties to be affected by this conference. However, we have learned that on February 7 the company gave its go ahead to have excavating machinery begin the actual digging of a canal. This indicates that the company intends to proceed with its projected plan regardless of the deliberations of this Federal-State conference.

As a part of its statement before this conference, I want the Florida Power & Light Company spokesman to declare that his company will not proceed with the canal excavation until the Federal and State requirements have been established. The parties to this conference prefer to have the expression of good faith from the company officials so that the option now available to the State and Federal Government will not be disturbed or foreclosed.

If the Florida Power & Light Company officials are unwilling to stay the construction of the canal, then I must announce that the Secretary of the Interior will request the Justice Department to seek appropriate remedies to protect the Biscayne Bay National Monument, including court action if necessary.

May I have your attention again? This conference

Opening Statement - Murray Stein

in the matter of pollution of the navigable waters of Biscayne Bay and its tributaries in the State of Florida is being held under the provisions of Section 10 of the Federal Water Pollution Control Act as amended. Under the provisions of the Act the Secretary of the Interior is authorized to initiate a conference of this type when requested to do so by a Governor of the State.

In a letter dated December 1, 1969, to the Honorable Walter J. Hickel, Secretary of the Interior, Governor Claude R. Kirk of Florida requested that a conference be called to consider pollution of the navigable waters of Biscayne Bay within the State of Florida.

On the basis of this request, Secretary Hickel, on December 11, 1969, sent the notice of conference to the official State water pollution control agency, which is the Florida Department of Air and Water Pollution Control.

Both the State and Federal Governments have responsibilities in dealing with water pollution control problems. The Federal Water Pollution Control Act declares that the States have primary rights and responsibilities for taking action to abate and control pollution.

Consistent with this, we are charged by law to encourage the States in these activities. At the same time, the Secretary of the Interior is charged by law with specific responsibilities in the field of water pollution control in connection with pollution of interstate and navigable waters. The Federal Water Pollution Control Act provides that pollution of interstate and navigable waters which endangers the health or welfare of any persons, shall be subject to abatement. This applies whether the matter causing or contributing to the pollution is discharged directly into such waters or reaches such waters after discharge into a tributary.

The purpose of the conference is to bring together representatives of the State agency, the U. S. Department of the Interior and other interested parties to review the existing situation and the progress which has been made, to lay a basis for future action by all parties concerned, and to give the State and, in this case, the Florida Power & Light Company an opportunity to take any indicated remedial action under State and local law.

The Florida Department of Air and Water Pollution Control will be represented by Mr. Nathaniel Reed and Mr.

Vincent Patton. The Federal conferee is Mr. John Thoman, who is the Southeast Regional Director of the Federal Water Pollution Control Administration, with headquarters in Atlanta.

Mr. Name is Murray Stein. I am from FWPCA Headquarters, U. S. Department of Interior, Washington, D. C., and the representative of Secretary Hickel.

The parties to this conference are the Florida Department of Air and Water Pollution Control and the United States Department of the Interior.

Participation in this conference will be open to representatives and invitees of these agencies and such other persons who inform me they wish to present statements.

However, only the representatives of the State Water Pollution Control Agency and the United States Department of the Interior constitute the conferees.

Now, a word about the procedures governing the conduct of the conference. The conferees will be called upon to make statements. Conferees, in addition, may call upon participants whom they have invited to the conference to make statements. We will also call on all other interested individuals who wish to present statements.

Opening Statement - Murray Stein

Everyone who wishes to speak will be given an apportunity to be heard. At the conclusion of each statement the conferees will be given an opportunity to comment or ask questions, and I may ask a question or two. This procedure has proven effective in the past in developing the facts and reaching equitable solutions.

I want to make it clear, we will not accept questions or comments after each speech or each statement from the floor. However, if you have any, just hold them, and when your turn comes you will be given a full opportunity to say whatever you wish. No one will be cut off, and we are here to hear everybody.

At the end of all the statements there will be an executive session by the conferees, and they will try to arrive at a basis of agreement on the facts of the situation, and we will have a statement after that executive session.

Under the Federal law, the Secretary of the Interior is required at the conclusion of the conference to prepare a summary of it, which will be sent to the conferees. The summary, according to law, must include the following points:

1. Occurrence of pollution of navigable waters,

subject to abatement under the Federal Act.

2. Adequacy of measures taken toward abatement of pollution; and

3. Nature of delays, if any, being encountered in abating the pollution.

A record and verbatim transcript of the conference is being made by Mr. Owen Colliflower. This is being made for the purpose of aiding us in preparing the summary and also for providing a complete record of what is said here.

It usually takes about three or four months for the transcript to come out in printed form. If you wish a record beforehand or any portion of it, you may check with Mr. Colliflower, who is the Reporter and an independent contractor, and you can make your own arrangements with him.

We shall make copies of the summary and transcript available to the official State Water Pollution Control Agency. We have generally found that for the purpose of maintaining relationships within the States that the people who wish summaries of transcripts should request them through the State agency rather than come directly to the Federal Government. The reason for this is that when the conference is concluded we would prefer people who are interested in the problem to follow the normal relationships in dealing directly with the

State agency rather than the Federal Government. This has worked successfully in the past, and we will be most happy to make this material available for distribution.

I would suggest that all speakers and participants other than the conferees making statements come to the lectern and identify themselves for the purpose of the record.

We will now call on Mr. Thoman from Federal Water Pollution Control Administration.

Pardon me. We will have an opening statement from Mr. Reed of Florida.

MR. REED: Mr. Stein, I do want to take this opportunity to recognize in the audience today Mr. John Roberts and Mr. A. D. Vincent of the Department of Air and Water Pollution Control. Also members of the Florida Legislature, the distinguished Representatives, Mr. Lewis, Mr. Fulford and Mr. Renick. Col. Fullerton, our District Engineer from Jacksonville, is also here.

We have asked to be here scientific talent from the Department of Parks, universities and industries. Also among our audience are distinguished concerned private citizens which we would like to particularly welcome.

I also have a brief opening statement from the

The Honorable Claude R. Kirk, Jr.

Governor which I would like to read at this time.

THE HONORABLE CLAUDE R. KIRK, JR.,
GOVERNOR, STATE OF FLORIDA (read by
NATHANIAL REED).

MR. REED: "Please welcome the participants and our guests to the conference.

"The environmental challenge facing our Nation is highlighted by the problems which will be discussed at today's hearing. South Florida desperately needs additional electrical power. The Turkey Point site was selected before the subtle effects of artificially increased water temperatures on marine biota were fully understood. The operation of the two conventional power units in the heat of summer conclusively indicated that a large problem could be expected when the nuclear units became operational in 1971 and 1972, unless some method of abating both the high discharge temperatures and the velocity of the flow was found.

"Biscayne Bay belongs to the people of Florida and the Nation. The bay maintains a rich, varied, but fragile ecology. Man must treat this bay gently or it will join the long roll call of other bays that have died unnatural deaths, due to man's pollution.

The Honorable Claude R. Kirk, Jr.

"I wish to point out to the participants and the Nation, the utter foolishness of allowing the Atomic Energy Commission the right to grant construction permits for sites such as Turkey Point without paying any attention to the ecological impact of the future operation. The Government regulatory agencies are squarely behind the eight ball where they have been deprived of the right to complete the necessary studies which could discover the serious environmental consequences of a proposed site.

"It is my hope that the attitude of today's meeting will be constructive.

"We do not have time to rehash history. The experts must solve this riddle; insuring adequate electrical power in South Florida, and preserving Biscayne Bay.

"Thank you."

MR. STEIN: Thank you, Mr. Reed.

Mr. Thoman, would you proceed with the Federal presentation?

MR. THOMAN: The Federal Water Pollution Control Administration presentation will be made by Mr. John Hagan and other representatives of his staff. Mr. Hagan is the Technical Director of our Lower Florida Estuary Studies, which was started about a year ago.

During this presentation we are going to have some slides; so if that one camera in the center can be moved, we would appreciate it.

JOHN E. HAGAN, TECHNICAL DIRECTOR OF THE
LOWER FLORIDA ESTUARY STUDY AND OPERATIONAL UNIT,
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, LOWER
FLORIDA ESTUARY PROJECT, HOLLYWOOD, FLORIDA

MR. HAGAN: Mr. Chairman, my name is John Hagan. I am the Technical Director of the Lower Florida Estuary Study and Operational Unit of the Federal Water Pollution Control Administration. My headquarters are in Fort Lauderdale, Florida.

I will be reading a report entitled "Report On Thermal Pollution of Intrastate Waters, Biscayne Bay, Florida." Copies of this report, along with copies of Appendix 1 and Appendix 2 have been delivered to the conferees and to the Court Reporter.

MR. STEIN: Are you going to read the whole report, or summarize it?

MR. HAGAN: I will read part of the report verbatim, and part of the water quality section will be paraphrased.

MR. STEIN: All right. Do you want the whole report to appear in the record as if read?

MR. HAGAN: Yes.

MR. STEIN: That will be done.

(The above-mentioned report follows.)

REPORT ON
THERMAL POLLUTION OF INTRASTATE WATERS
BISCAYNE BAY, FLORIDA

MARCH 3, 1849

February 1970

U.S. Department of the Interior
Federal Water Pollution Control Administration
Southeast Water Laboratory
Technical Services Program
Lower Florida Estuary Study
Ft. Lauderdale, Florida

REPORT ON
THERMAL POLLUTION OF INTRASTATE WATERS
OF
BISCAYNE BAY, FLORIDA

U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST WATER LABORATORY
Technical Services Program
Lower Florida Estuary Study
Ft. Lauderdale, Florida

February 1970

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE NO.
I	INTRODUCTION	1
II	CONCLUSIONS AND RECOMMENDATIONS	2
III	AREA	4
IV	WATER USE	7
V	TURKEY POINT POWER PLANT	12
	A. Present Operation	12
	B. Planned Operation	14
VI	STATUS OF THERMAL CONTROL PROGRAM	15
VII	WATER QUALITY	16
	A. Review of Previous Data	16
	B. FWPCA Field Activities	17
	C. Circulation	24
	D. Temperature Effects	25
	E. Biological Effects	27
VIII	DISCUSSION	41
	REFERENCES	44
	APPENDIX A - TEMPERATURE STUDIES, LOWER BISCAYNE BAY - OCTOBER 1968	

LIST OF TABLES

TABLE	TITLE	FOLLOWS PAGE NO.
1	Temperature, Dissolved Oxygen and Chloride Concentration - Biscayne Bay at Turkey Point - 9/30/69 - 10/2/69	18
2	Summary of Chemical Data - Biscayne Bay at Turkey Point - 9/30/69 - 10/2/69	20
3	Temperature, Dissolved Oxygen, and Chloride Concentration - Biscayne Bay at Turkey Point - 1/17/70 - 1/19/70	22
4	Summary of Chemical Data - Biscayne Bay at Turkey Point - 1/17/70 - 1/19/70	22
5	Temperature, Dissolved Oxygen and Chloride Concentration - Card Sound - 1/15/70	23
6	Summary of Chemical Data - Card Sound - 1/15/70	24
7	Monthly Average of Maximum Daily Temperature	43

LIST OF FIGURES

FIGURE	TITLE	FOLLOWS PAGE NO.
1	Study Area	4
2	Turkey Point & Vicinity	12
3	Predicted Temperature Rise Fossil Units 1 & 2	12
4	System Daily Load Curves	13
5	Frequency Distribution of Temperature Rise Across Condensers at Turkey Point Units 1 & 2 June 1969	13
6	Frequency Distribution of Temperature Rise Across Condensers at Turkey Point Units 1 & 2 July 1969	13
7	Frequency Distribution of Temperature Rise Across Condensers at Turkey Point Units 1 & 2 Aug. 1969	13
8	Predicted Temperature Rise Nuclear Units	14
9	Water Quality Sampling Stations 1969 & 1970	17
10	Card Sound Water Quality Sampling Stations January 1970	23
11	Peak Surface Dye Concentrations	24
12	Lower Biscayne Bay 75° Magnetic from Grand Canal June 1969	26
13	Temperature Monitor Locations	26
14	Monthly Mean of Maximum Daily Temp. Aug. 1969	27
15	Bottom Temperature Equalled or Exceeded 10% of the Time August 1969	27
16	Monthly Maximum Temperature August 1969	27
17	Estimated Zone of Biological Damage 1968	30
18	Biological Damage Zone - 1969	35

I. INTRODUCTION

In December 1967, the Governor of Florida and the Florida State Board of Health requested assistance from the Federal Water Pollution Control Administration in making an environmental study of Biscayne Bay and a comprehensive study of Lake Worth. The Governor specifically requested an evaluation of the effects of heated water discharge from a planned nuclear power plant on the quality of Biscayne Bay.

In the summer of 1968, personnel from the Southeast Water Laboratory, Athens, Georgia, conducted an extensive temperature monitoring study of the lower bay. The results of this study are contained in a report "Temperature Studies, Lower Biscayne Bay," October 1968, and are included as Appendix A to this report.

In the spring of 1969, a permanent team of investigators was assigned to the area to conduct studies of the lower Florida estuary area, including Lower Biscayne Bay.

This report on the effects of heated effluent on Biscayne Bay near Turkey Point and on the present water quality and biological system of Biscayne Bay and Card Sound is based on: previous reports, investigations of the University of Miami Institute of Marine Sciences, information and data furnished by the Florida Power and Light Company, and field investigations by the Federal Water Pollution Control Administration.

The cooperation and assistance of the several agencies and individuals who have contributed to this effort is gratefully acknowledged.

II. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Severe damage has occurred to the aquatic plant and animal population of Lower Biscayne Bay due to the present heated effluent from the Turkey Point plant of the Florida Power and Light Company.

2. No man-made pollution or any physical condition other than elevated temperature is present which could account for the observed biological damage in Lower Biscayne Bay.

3. Under the most conservative present operating conditions, the temperature rise of the cooling water, across the condensers, will exceed 10^{o}F at least 16% of the time.

4. The cooling water effluent discharged from Grand Canal moves in a northeasterly direction around Turkey Point. This path coincides with the zone of biological degradation.

5. The biological degradation zone covers about 670 acres of Lower Biscayne Bay as observed during the summer of 1969.

6. A wide variety of both aquatic plants and animals were killed in late June 1969. This damage to aquatic life and vegetation is directly attributable to the discharge of heated effluent from the Turkey Point facility of Florida Power and Light Company.

7. The monthly mean of the maximum daily temperatures in areas of Lower Biscayne Bay outside the influence of artificially elevated temperatures resulting from waste cooling water is 83^{o}F in June, 85.6^{o}F in July and 87.3^{o}F in August. (1968)

8. The additional operation of two nuclear powered generating units at the Turkey Point plant will increase the waste heat load by four times over that presently discharged (without proper thermal control). This increased heat load will intensify the present damage in extent, severity and frequency.

9. If waste heat from the Turkey Point facility is discharged to Card Sound, as presently proposed by the Florida Power and Light Company, temperatures in excess of 95°F can be expected in at least 35% of Card Sound, five percent of the time.

B. Recommendations

1. The Florida Power and Light Company shall abate the excessive waste heat load being discharged from its Turkey Point power plant to the levels recommended by the National Technical Advisory Committee to the Secretary of the Interior for estuarine waters. The Committee has recommended that the monthly mean of the maximum daily temperatures should not be raised more than 4°F during the fall, winter and spring (September through May) or by more than 1.5°F during the summer (June through August).

2. The Federal Water Pollution Control Administration in cooperation with the State of Florida and the Florida Power and Light Company establish a temperature monitoring program to determine compliance with the recommended temperature requirements as above.

III. AREA

LOWER BISCAYNE BAY AND CARD SOUND

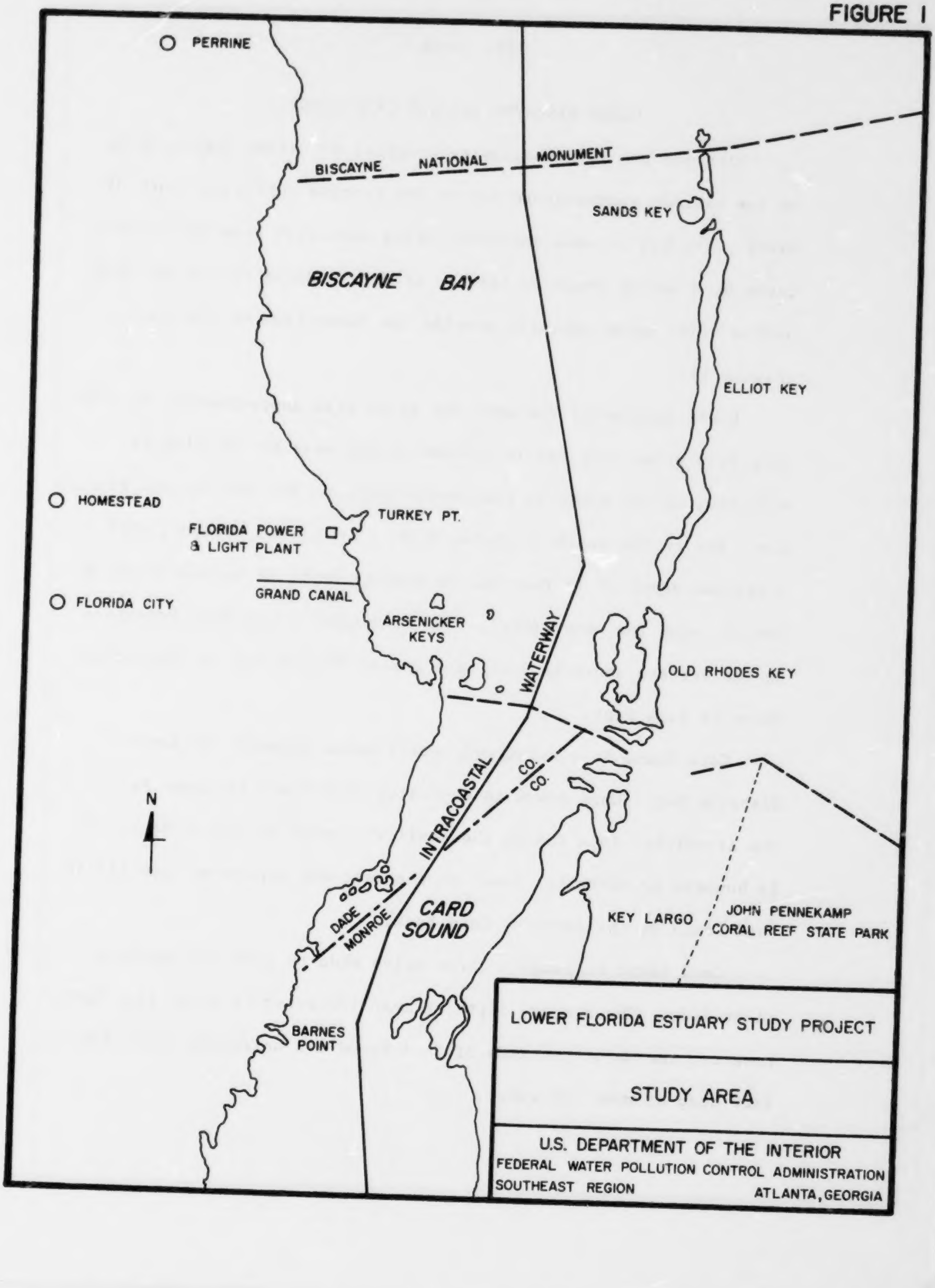
Biscayne Bay is a shallow subtropical estuarine lagoon lying on the extreme southeastern tip of the Florida peninsula south of Miami. The bay is semi-enclosed, being separated from the Atlantic Ocean by a narrow chain of barrier islands. Broad shoals and deep narrow tidal surge channels provide the connection to the ocean (Figure 1).

Lower (southern) Biscayne Bay is an area approximately 11 miles long by 9 miles wide and is bounded on the west by the Florida mainland, on the north by Featherbed Bank, on the east by the Florida Keys, and on the south by Cutter Bank. The bay is shallow, with a maximum depth of 13 feet and an average depth of between 5 and 6 feet at mean low water (MLW). The mean tidal range near Homestead on the western shore is 1.65 feet and at Elliott Key on the eastern shore is 1.54 feet.

Card Sound is a relatively small basin adjacent to Lower Biscayne Bay. Card Sound is separated from South Biscayne Bay by the Arsenicker Keys and by the shallows formed by Cutter Bank. It is bounded by north Key Largo on the east and separated from Little Card Sound on the south by Card Bank.

Card Sound is roughly three miles wide by five and one-half miles long. The average depth at mean low water is about nine feet; however, the major portions of Card Sound are uniformly about ten feet deep at mean low water.

FIGURE I


PERRINE
BISCAYNE NATIONAL MONUMENT
SANDS KEY
BISCAYNE BAY
ELLIOT KEY
HOMESTEAD
TURKEY PT.
FLORIDA POWER & LIGHT PLANT
GRAND CANAL
FLORIDA CITY
ARSENICKER KEYS
INTRACOASTAL WATERWAY
OLD RHODES KEY
CO.
CO.
N
DADE
MONROE
CARD SOUND
KEY LARGO
JOHN PENNEKAMP CORAL REEF STATE PARK
BARNES POINT
LOWER FLORIDA ESTUARY STUDY PROJECT
STUDY AREA
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION
ATLANTA, GEORGIA

With the exception of Card Bank at the southern end and Cutter Bank at the northern end, Card Sound does not have the extensive shallow "grass bed" shoreline typical of Lower Biscayne Bay. The bordering subtidal shallows drop precipitously into a deeper Card Sound Basin.

The tidal exchange of water between Card Sound and Lower Biscayne Bay is over the shallows of Cutter Bank, which at mean low water ranges from six inches to two feet deep. Flow to the south must pass over Card Bank and through the narrow passage from Little Card Sound to Barnes Sound.

Exchange of Card Sound water with the ocean is confined to the surge channels or creeks at north Key Largo; namely, Angelfish Creek and Broad Creek. Before these channels enter Card Sound, they form shallow dendrite paths over the top of shallow banks from one to four feet deep at mean low water.

The input of fresh water to Card Sound from land drainage is limited to runoff from Key Largo, the mainland east of salt water barrier levee, and from the Model Land Canal. Thus, fresh water input is most likely limited to the small drainage southeast of Florida City and is intermittent with slugs of fresh water to the Sound during and following periods of heavy rainfall.

The climate of Dade County is warm and mild and may be described as subtropical. Extreme temperatures range from the mid 90's in July or August to mid 30's in January or February. However, average temperatures for July and August are about 82°F and for January and

February are about 69°F. Annual rainfall is about 60 inches with 75-80 percent occurring June through October. During that same period, the relative humidity is quite high, ranging from 60 to 90 percent of saturation.

IV. WATER USE

At present, Biscayne Bay is used for commercial and sport fishing, shellfishing, commercial sponge harvesting, sailboating, motor boating, wading, skiing, swimming, snorkel and SCUBA diving and aesthetic enjoyment.

Few places in the world have more beautiful or spectacular birds than South Florida. Most important in Biscayne Bay are the wading and shore birds. These are found principally in the shallows, extensive mangrove shoreline and the small mangrove islands in the extreme south portion of the bay. Several species can usually be seen wading in the shallows, among them some of the rare and endangered species. Birds commonly observed include heron, pelican, cormorant, egret, white ibis, roseate spoonbill, frigate birds, waterfowl, gulls and terns.

Plants of Biscayne Bay serve a valuable ecological purpose, including the production of a rich substrate supporting and sheltering invertebrate population and stabilizing the bay bottom and the shoreline. The richly vegetated bay bottom serves as a nursery for the valuable sport and commercial fishery and has an important role in the productivity of all the marine resources in the area. These animals and plants are the nutrient base of all life in the bay.

There are in Biscayne Bay at least 27 species of fish which are of major importance for commercial, sport, or bait fishing, including mullet, barracuda, mackerel, jack, snapper, grouper, bonefish, snook and pompano. There are at least nine invertebrates occurring in the bay which are of major importance. These include sponges, queen conch, blue crab, stone crab, shrimp, and spiny lobster. In addition, there are at least 18 species which are of minor commercial significance. (1)

In 1965, bait shrimp fishery alone had a value of $393,600. Stone crabs were the second most valuable commercial fishery, netting a catch valued at $145,828 in 1965. Spiny lobsters from Biscayne Bay brought $81,000 to commercial lobstermen. In addition, a considerable but unrecorded sport fishery also exists. (1)

For residents of South Florida, Biscayne Bay offers the most convenient, attractive and diverse recreational opportunities. It is projected that 2.7 million people will reside in the four-county area (Dade, Broward, Palm Beach and Monroe) by 1980. Of that number, approximately one million will be in the 18-44 age group -- the active years for outdoor recreation. By that time, an estimated 1.36 million instances of participation in outdoor recreation will occur, of which water-oriented activities will account for about 78 percent. (2)

According to a 1967 tourist study conducted by the Florida Development Commission, 73 percent of the tourists entering Florida by all means of transportation looked forward to beaches and swimming. (2)

The Congress of the United States, on October 18, 1968, enacted PL 90-606 authorizing $24,575,000 for the purchase of property for the Biscayne National Monument and $2,900,000 for Monument development. In doing so, the Congress recognized the unique value of this subtropical estuary lagoon area and set it aside as a preserve for the enjoyment of the public. The purpose of authorizing the Monument's establishment was to "...preserve and protect for the education, inspiration, recreation, and enjoyment of present and future generations a rare combination of terrestrial, marine, and amphibian life in a geographical setting of great natural beauty...." (3)

The Biscayne National Monument would be located in Lower Biscayne Bay, approximately 20 miles south of Miami. The entire area within the Monument would be about 11½ miles from north to south and an average of 12 miles from east to west. It would consist of about 96,300 acres, 3,900 acres of which are land and mangrove swamps consisting of the Upper Florida Keys, a chain of narrow islands separating Biscayne Bay from the Atlantic Ocean. About 92,400 acres (approximately 96%) are submerged, consisting of the adjoining bay and ocean waters, and is accessible only by boat. (See Figure 1.)

The boundaries of the Monument would encompass some 33 islands and keys lying between but not including Key Biscayne and Key Largo. The keys included in the Monument are among the most northerly of the chain of islands stretching from Virginia Key, just south of Miami Beach, to Key West and beyond. Principal keys within the area are the 1,700-acre Elliott Key and Sands, Adams and Rhodes Keys; many other keys a fraction of an acre in size would also be included.

On the north, the boundary runs between Boca Chita and Sands Keys; on the east it follows the 60-foot depth line in the Atlantic Ocean; on the south it runs along the northern boundary of a possible shipping channel entering into Broad Creek; on the west it generally follows the outer dredging limit line established by the Dade County Commissioners, generally parallel to and within 400 to 1,000 feet from the mainland. The extension of the west boundary of the Monument to near the mainland is intended to protect the submerged lands of Biscayne Bay from unwarranted channel development, commercial dredging and filling, pollution, and other activities which may alter or upset the marine ecology and underwater circulation patterns.

Title to all but about 400 acres of the submerged land in Biscayne Bay plus part of the submerged land on the ocean side of the keys is held by the State of Florida. The remainder is held by the United States. The State, by resolution dated July 9, 1968, acting through its Internal Improvement Fund (IIF), has agreed to turn over State-owned submerged land to the United States subject to (1) Congressional authorization and designation of the proposed Monument, and (2) Congressional authorization for appropiration of Federal funds for acquisition of all non-Federally owned lands within the Monument area, with such acquisition to provide just compensation to owners.

An area not to exceed 80 acres has been planned on the mainland as a headquarters site near Homestead Bayfront Park, and an area not to exceed 40 acres is also planned on Key Largo as a secondary visitor contact station along Card Sound in the northern part of Key Largo. This would provide access to the Monument from Card Sound.

A visitor contact point is projected at Elliott Key. Developments are planned for shelters, enlarged docking facilities and primitive campgrounds at this location. Fishing, diving, snorkeling, bicycling, picnicking and hiking may be enjoyed.

A secondary public-use facility to supplement the one on Elliott Key would be on Sands Key to the north. Visitor contact, picnicking, and boat docking will be available. A similar facility would be located on Adams Key to the south.

The results of an economic study of the Monument's feasibility include the projection that by 1975 approximately 750,000 persons will be visiting the Monument on an annual basis, and the related annual expenditure at or near the park has been estimated to be $9,150,000. (2)

V. TURKEY POINT POWER PROJECT

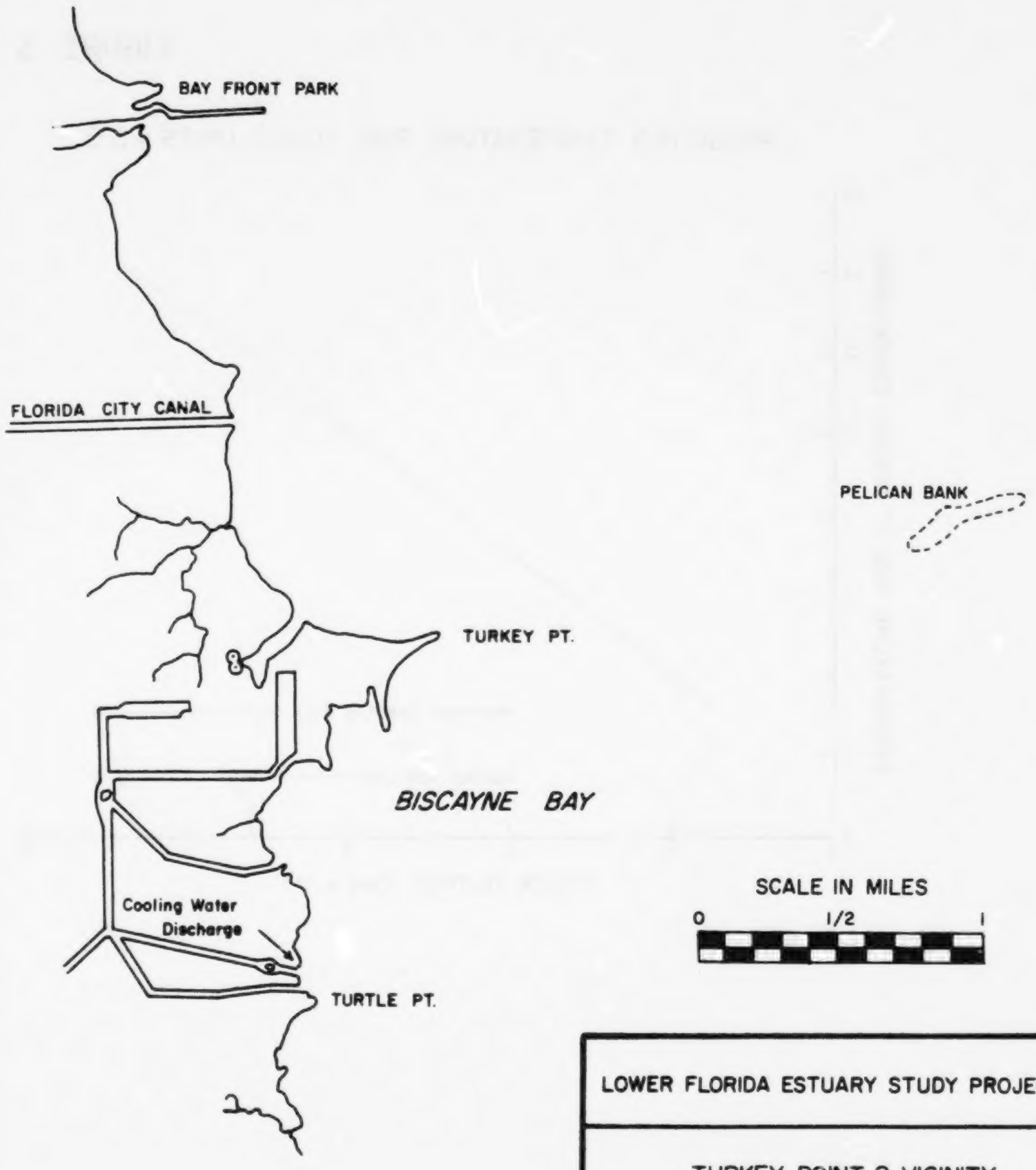
A. Present Operation

The Dade Metro Commission granted the Florida Power and Light Company a permit in June 1964 and construction of the two oil-fired units (referred to as Units 1 and 2) began in September of that year. Unit 1 was placed on line April 22, 1967 and Unit 2 went into operation April 25, 1968. These two conventional (oil-fired) units represent the presently installed capacity of the Turkey Point Power Plant. The plant is located on 3500 acres at and adjacent to Turkey Point (Figure 2).

Units 1 and 2 each have 432,000 KW maximum capacity, with normal load capacity of 360,000 KW. Each unit requires 635 cubic feet per second (cfs) of condenser cooling water, or a total of 1270 cfs (820 million gallons a day) for both units. Water for cooling purposes is drawn from Biscayne Bay at an intake located just north of and immediately adjacent to Turkey Point. It is discharged back into the bay about two miles south of Turkey Point via a series of canals located on FP&L property.

The amount of water flowing through the condensers remains constant so that the rise in water temperature is a function of power generation load. Projected temperature rise across the condenser at various power loadings in shown in Figure 3. At the normal full load of 360,000 KW the temperature rise is approximately 12°F and at maximum capacity of 432,000 KW the temperature rise is approximately 14°F.

FIGURE 2


BAY FRONT PARK
FLORIDA CITY CANAL
PELICAN BANK
TURKEY PT.
BISCAYNE BAY
SCALE IN MILES
0
1/2
1
Cooling Water Discharge
TURTLE PT.

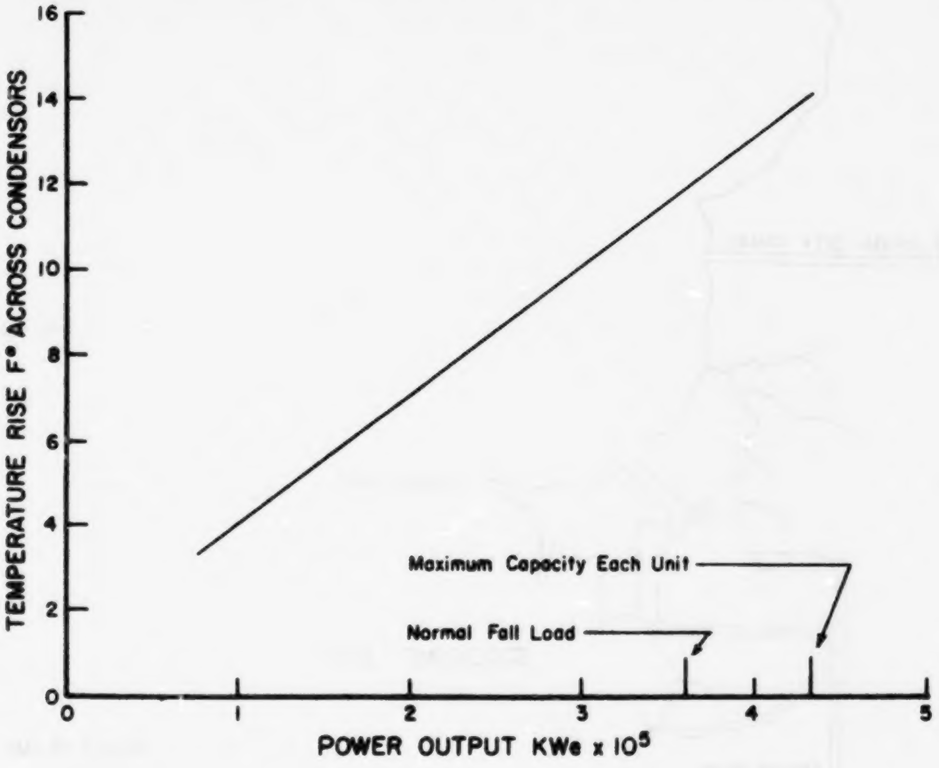
LOWER FLORIDA ESTUARY STUDY PROJECT

TURKEY POINT & VICINITY

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE 3

PREDICTED TEMPERATURE RISE FOSSIL UNITS 1 & 2



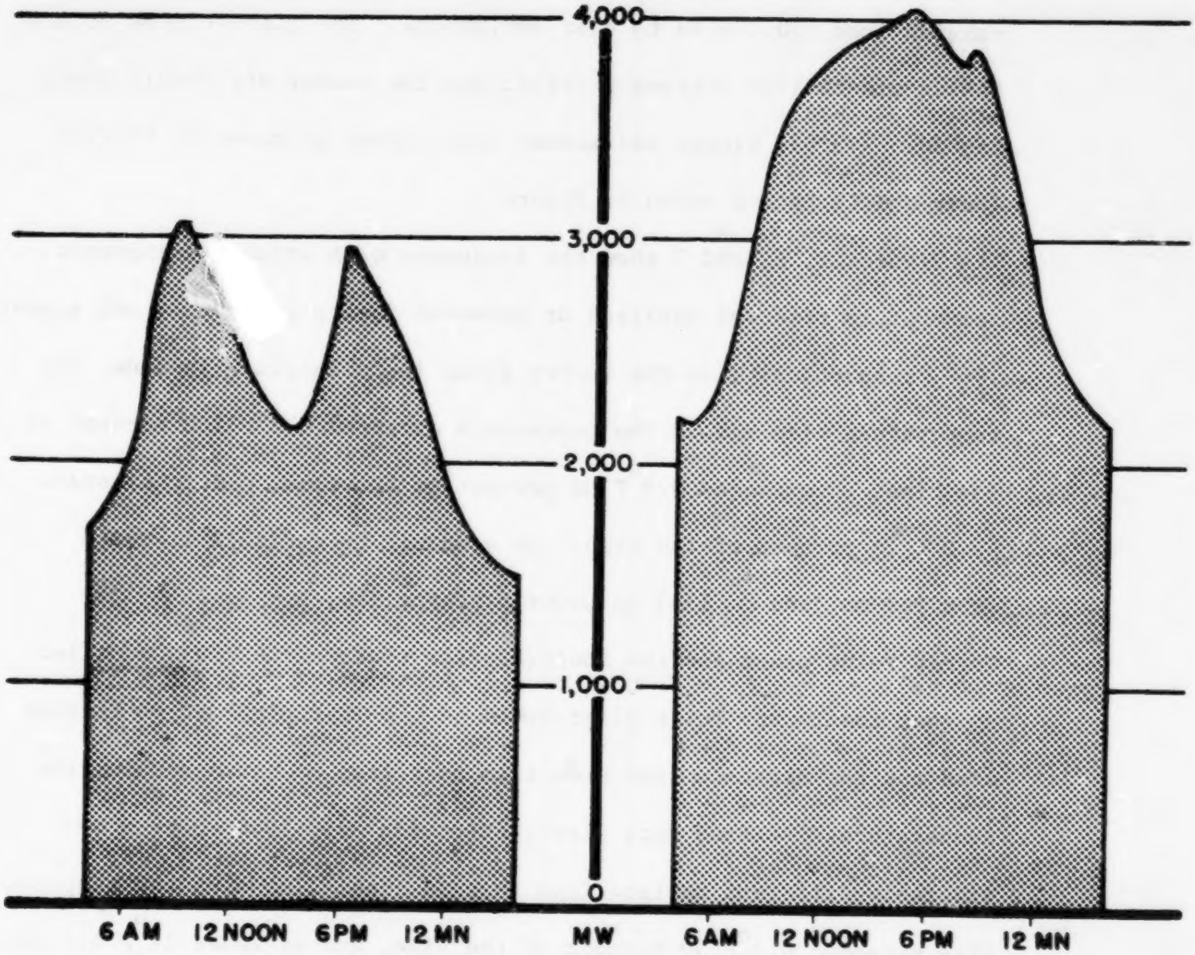
Hourly observations of power load at the Turkey Point plant and for the Florida Power and Light system as a whole for the months of June, July and August 1969 were supplied by the Company. These data indicate a wide daily fluctuation in power demand at Turkey Point ranging from 150,000 KW to over 780,000 KW. The highest peak occurs in the mid-to-late afternoon reflecting the summer air-conditioning demand. Typical winter and summer load curves prepared by Florida Power and Light are shown in Figure 4.

Figures 5, 6, and 7 show the frequency with which the expected temperature rise was equalled or exceeded during June, July and August 1969, respectively, at the Turkey Point installation. In June, the temperature rise across the condensers exceeded 3.3°F 100 percent of the time; it exceeded 9.9°F 50 percent of the time, and it exceeded 12.0°F 16 percent of the time. As a result of a fish kill which occurred on June 25, 1969 in Lower Biscayne Bay, operation of the Turkey Point plant and the South Florida power network was modified so that the Turkey Point plant would be the last plant to go to peak load and the first to come down from peak load.[1/] As a result, the temperature rise frequency distribution for July 1969 shows a considerably different pattern from that in June. In July, the temperature rise exceeded 6.3°F 50 percent of the time, and exceeded 12°F 5.5 percent of the time. In August, the frequency of the 12°F temperature rise increased to 16.4 percent of the time. Fifty percent of the time the temperature rise equalled or exceeded 9.8°F, and a rise of 3.3°F was equalled or exceeded 100 percent of the time.

[1/] Personal communication with Mr. C. M. Davis, Vice-President, FP&L Co.

FIGURE 4

SYSTEM DAILY LOAD CURVES



WINTER

SUMMER

1968

FIGURE 5

FREQUENCY DISTRIBUTION OF TEMPERATURE RISE ACROSS CONDENSERS AT TURKEY POINT UNITS 1 & 2 JUNE 1969

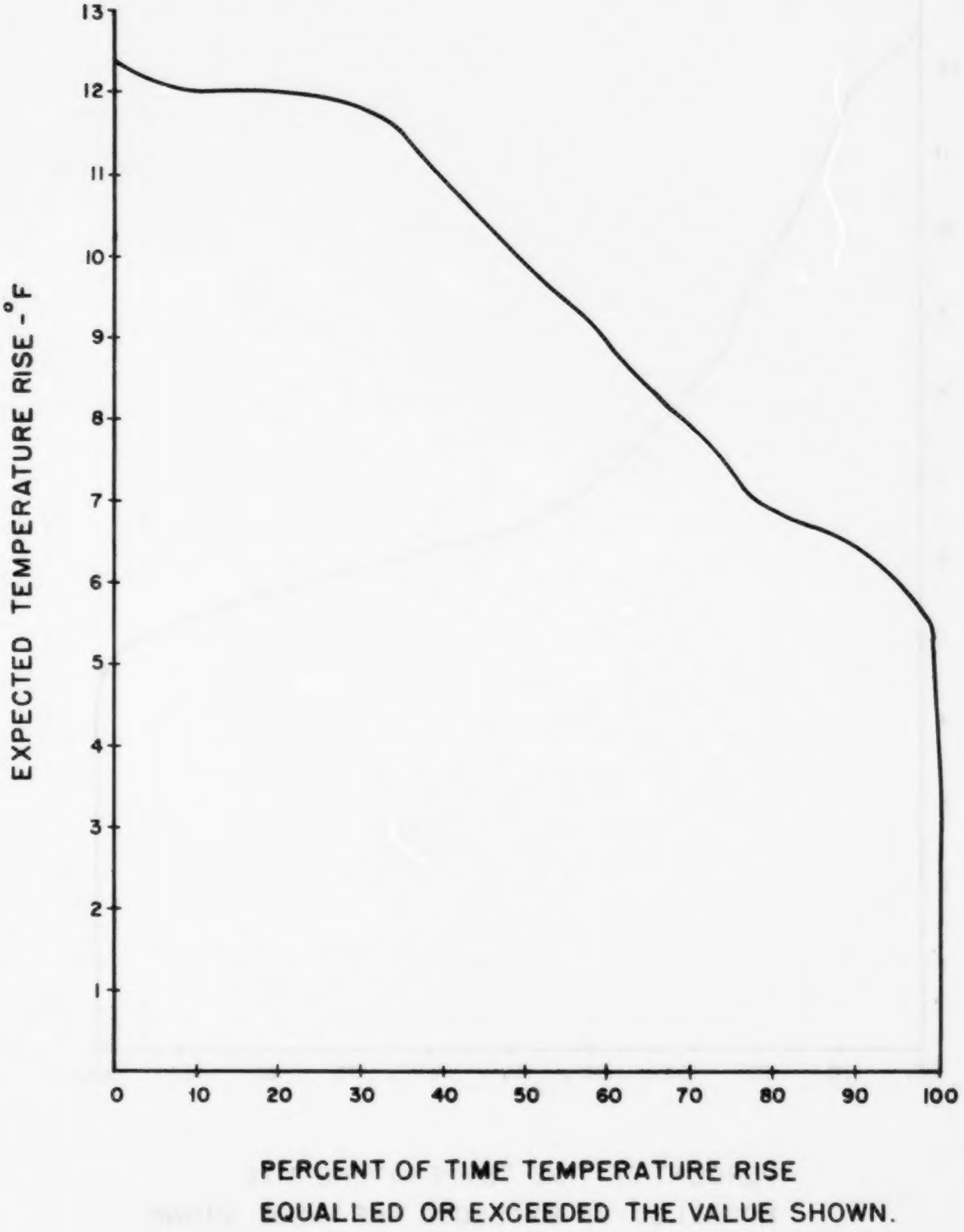
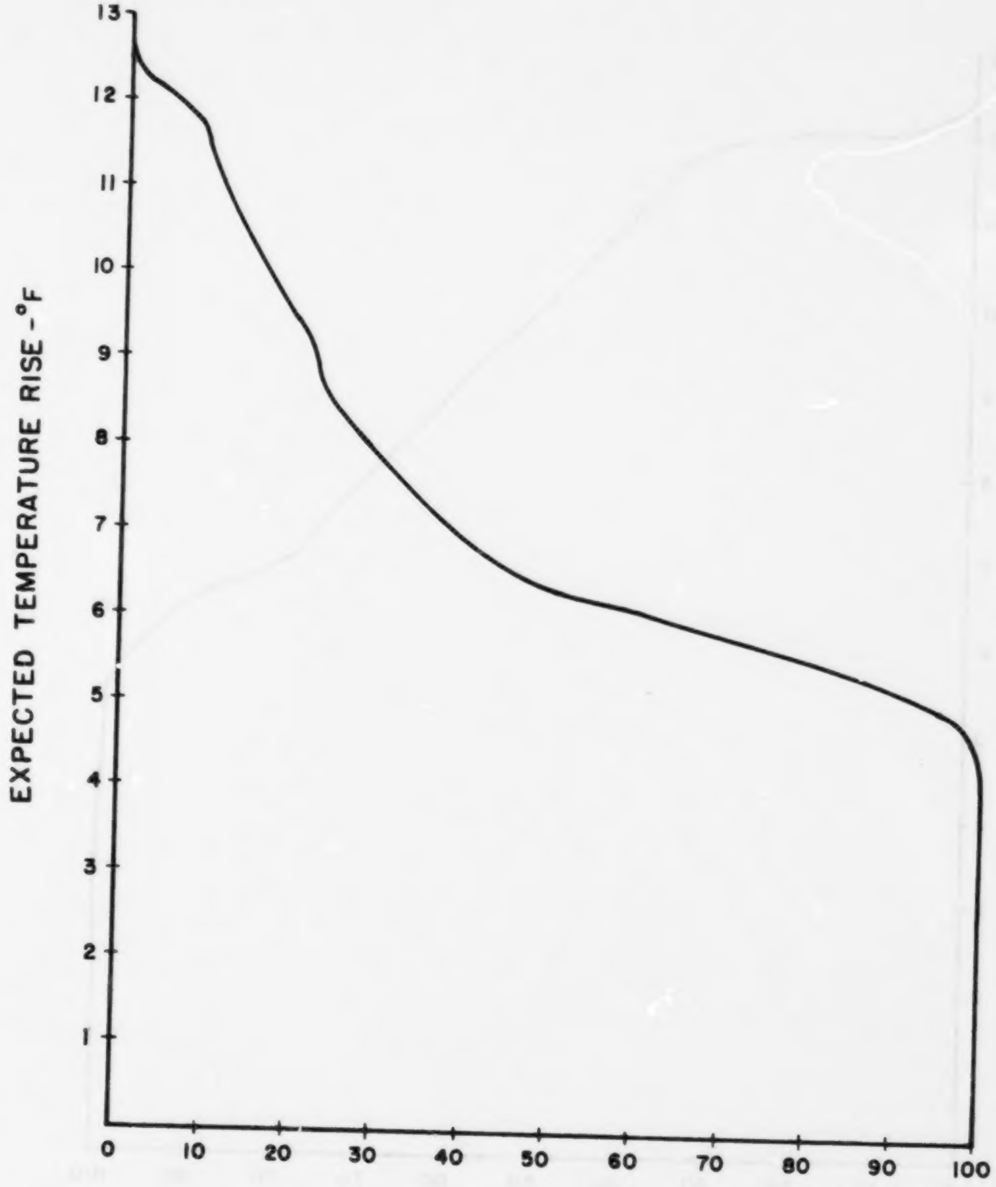


FIGURE 6

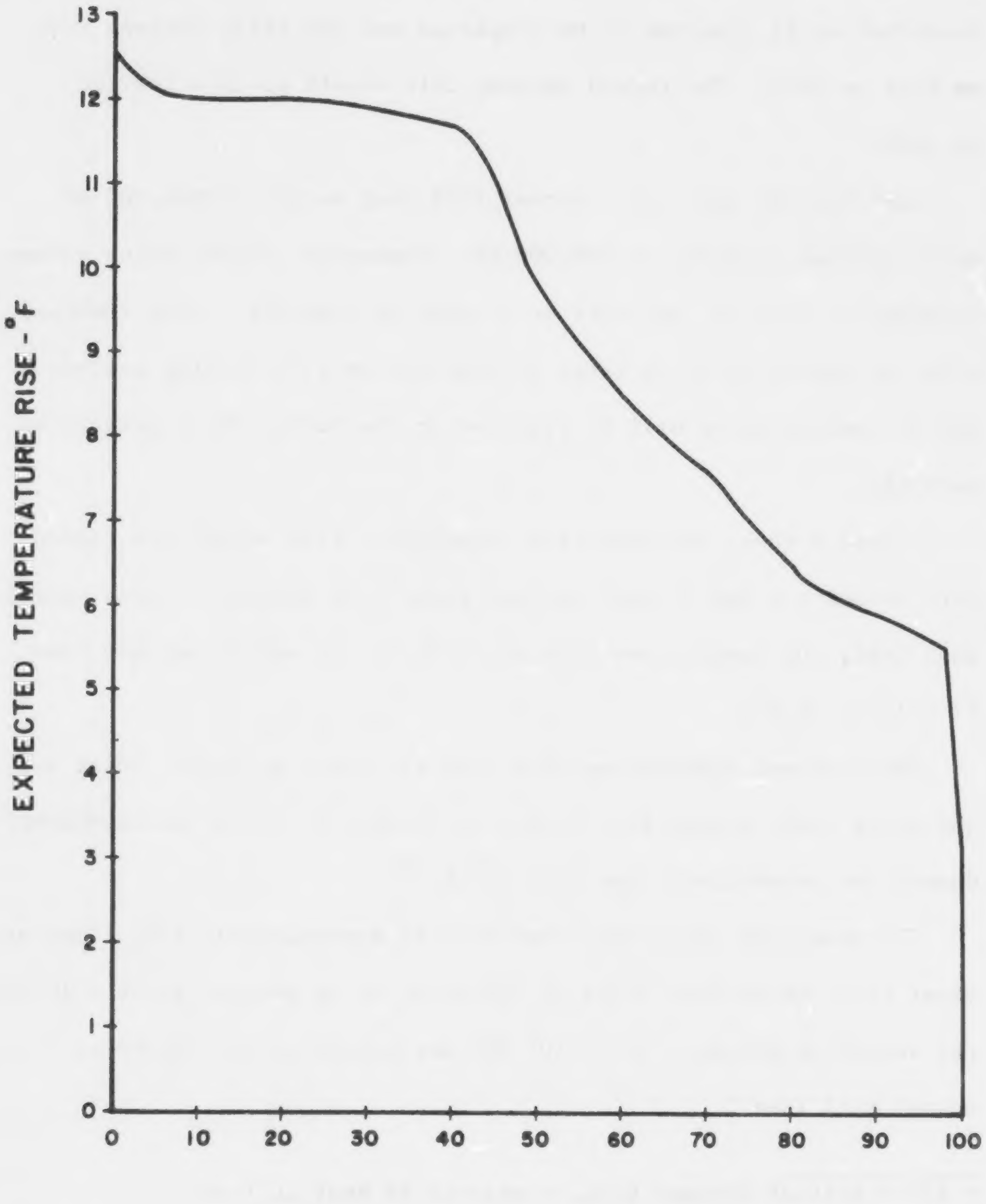
FREQUENCY DISTRIBUTION OF TEMPERATURE RISE ACROSS CONDENSERS AT TURKEY POINT UNITS 1 & 2 JULY 1969



PERCENT OF TIME TEMPERATURE RISE EQUALLED OR EXCEEDED THE VALUE SHOWN.

FIGURE 7

FREQUENCY DISTRIBUTION OF TEMPERATURE RISE ACROSS CONDENSERS AT TURKEY POINT UNITS 1 & 2 AUG. 1969



PERCENT OF TIME TEMPERATURE RISE EQUALS OR EXCEEDS VALUE SHOWN.

B. Planned Operation

On November 15, 1965, the Company announced plans to construct two 760,000 KW nuclear powered units at Turkey Point. Permits were acquired from the Atomic Energy Commission and the Dade Metro Commission. Construction was begun in early 1967 on Units 3 and 4. Construction is expected to be completed and the first nuclear unit on line in 1971. The second nuclear unit should go into service in 1972.

Each nuclear unit has a normal full load output of 680,000 KW and a maximum capacity of 760,000 KW. Condenser cooling water volume required is 1490 cfs per unit or a total of 2980 cfs. When combined with the fossil units, a total of 4250 cfs or 2.75 billion gallons a day of cooling water will be required at the Turkey Point generating facility.

Figure 8 shows the predicted temperature rise across the condensers of Units 3 and 4 under various power load demands. Under normal full load, the temperature rise would be 15.2°F and at maximum load it will be 16.8°F.

The combined temperature rise when all units at Turkey Point are operating under normal full load will be 14.2°F. Under maximum power demand the temperature rise will be 15.9°F.

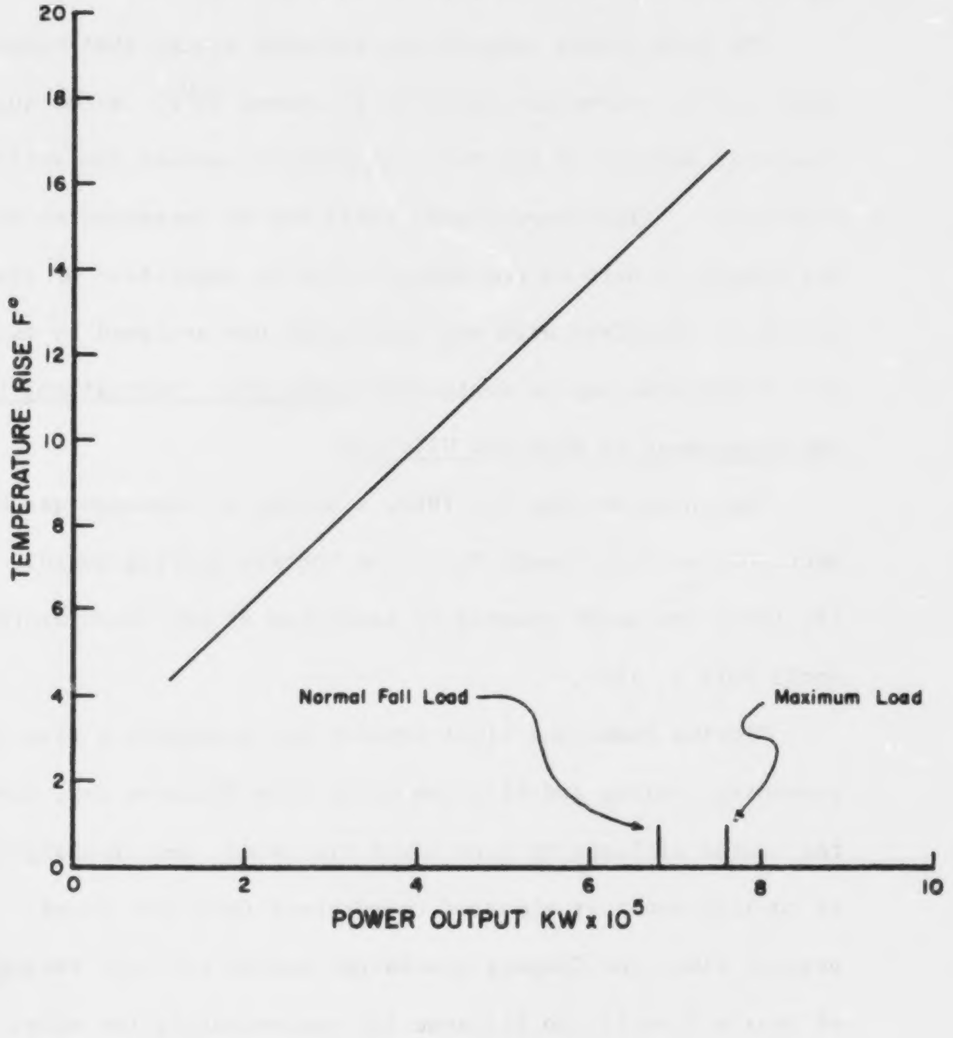
The predicted waste heat load will be approximately four times as great with the nuclear units in operation as at present (0.98×10^6 BTU* per second at present; 3.9×10^6 BTU per second in the future at normal full load.)

---

* BTU = British Thermal Unit, a measure of heat content.

FIGURE 8

PREDICTED TEMPERATURE RISE NUCLEAR UNITS



VI. STATUS OF THERMAL CONTROL PROGRAM

Subsequent to the start of operation of Units 1 and 2, and after the issuance of the construction permit for Units 3 and 4, the Florida Power and Light Company, on October 16, 1968, applied to Dade County for a temperature variance. This variance was granted on February 20, 1969 and expired on July 31, 1969.

The Dade County temperature standard states that temperatures shall not be raised artificially to exceed 95°F. Water quality standards adopted by the State of Florida contain the following statement: "(The temperature) shall not be increased so as to cause any damage or harm to the aquatic life or vegetation of the receiving waters or interfere with any beneficial use assigned to such waters." All of Biscayne Bay is designated Class III: Recreation, Propagation and Management of Fish and Wildlife.

Beginning on June 23, 1969, a series of hearings was held by the Metropolitan Dade County Pollution Control Hearing Board. On November 18, 1969, the Board granted an extension of the temperature variance until July 1, 1971.

Florida Power and Light Company has presented a plan calling for: providing cooling and dilution water from Biscayne Bay, transporting the heated effluent to Card Sound via canal, and discharging 8500 cfs of cooling water at elevated temperature into Card Sound. At the present time, the Company discharges heated effluent through a system of canals directly to Biscayne Bay approximately two miles south of the plant.

VII. WATER QUALITY

A. Review of Previous Data

Water quality studies have been conducted in Lower Biscayne Bay and Card Sound by several organizations including the Department of the Interior, the University of Miami Institute of Marine Sciences, and Florida State Board of Health.

Conclusions of a State Board of Health report in 1962 were: 1) "The area of Biscayne Bay covered in this survey (between Featherbed Bank and Turkey Point) is chemically the equivalent of good, clean ocean water. Some fresh water influence is apparent at the sampling points in the general vicinity of the canal outfalls. 2) (Biologically) The lower part of the bay near Homestead is in a completely healthy condition. 3) The effluent from the Homestead sewage treatment plant...has caused a noticeably heavier growth of bottom vegetation near the mouth of the canal." (4) Actual data are not available to describe the load entering the bay from the Homestead sewage treatment plant; however, the 1962 Inventory of Municipal Waste Facilities shows a population of 8050, served by a biological secondary treatment plant which discharged an estimated population equivalent of 800. (5)

Unpublished data collected by the Institute of Marine Sciences, University of Miami, are primarily hydrographic, consisting almost entirely of temperature, salinity, and dissolved oxygen measurements. Examination indicates that during the summer months there are instances of dissolved oxygen concentrations reaching 3.0 mg/l or lower for short periods of time. Data collected early in the morning have generally lower DO values than samples collected during midday or afternoon. This pattern is indicative of normal diurnal variations resulting from biotic respiration and has been observed during FWPCA round-the-clock surveys. Other than the instance above, all other data indicate that dissolved oxygen levels are well above 4.0 mg/l, the official Florida criterion.

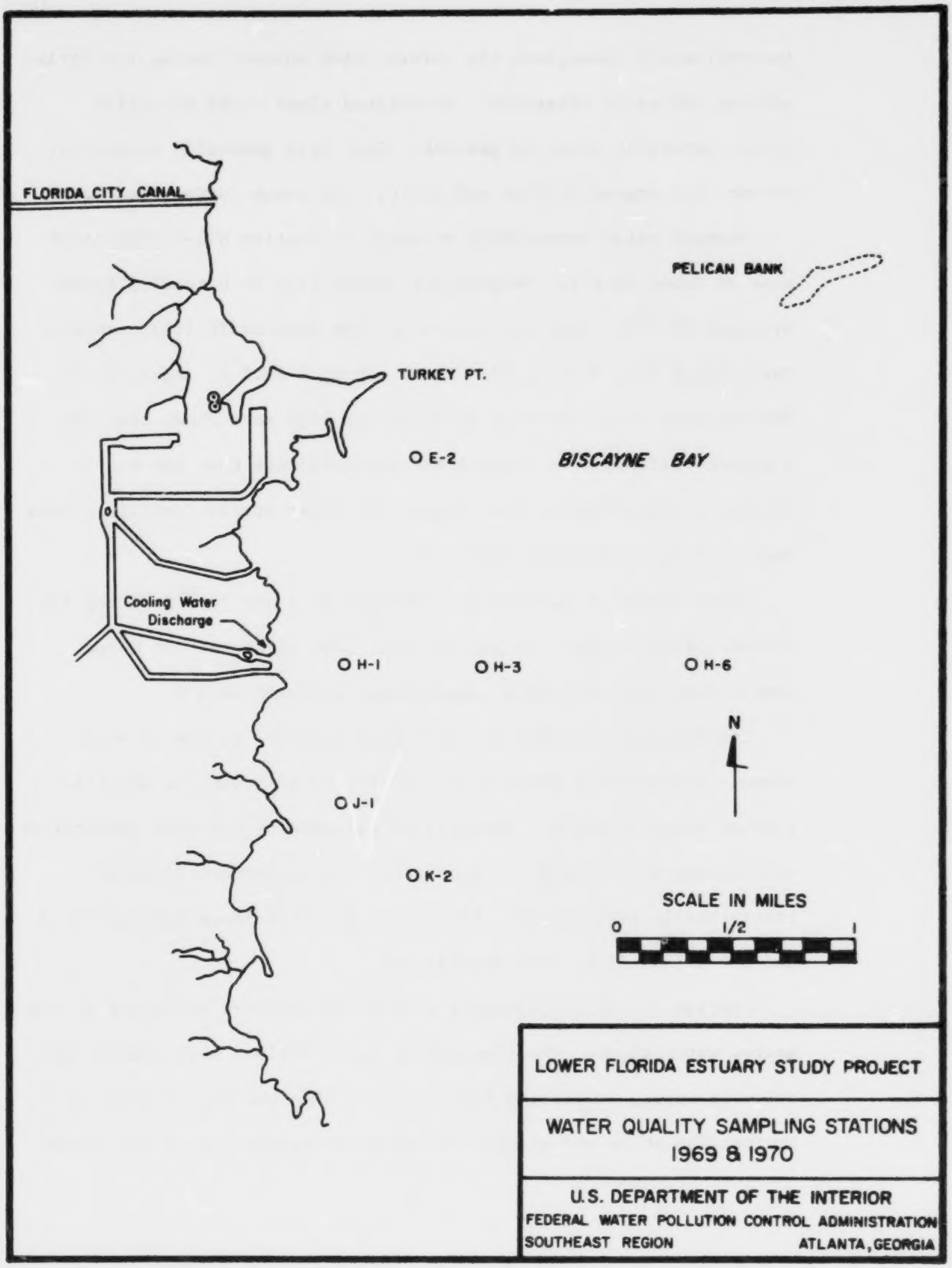
Researchers at the University of Miami, School for Marine and Atmospheric Sciences, studying the effects of thermal pollution from Florida Power and Light's Turkey Point power plant have identified 58 species of fish, 87 molluscs, 46 crustaceans, 15 sponges, 16 echinoderms, 25 polycheates and 5 miscellaneous animals collected in the vicinity of Turkey Point. In addition, 25 species of algae and marine "grasses" have been identified (Anon, 1969).

B. FWPCA Field Activities

Water quality studies were conducted in Lower Biscayne Bay between September 30 and October 2, 1969, and on January 17, 18 and 19, 1970. Samples were collected from the surface and bottom at two-hour intervals for a period of 48 hours at five locations adjacent to Turkey Point and east of Grand Canal, the major discharge point for the cooling water (Figure 9).

Air temperatures during the survey ranged from 74 to 91°F and averaged 83.2°F. Winds were generally from the south and varied from calm to 15 knots. Strongest winds were accompanied by a severe rain squall on the morning of October 2nd. Rain occurred

FIGURE 9


FLORIDA CITY CANAL
PELICAN BANK
TURKEY PT.
E-2
BISCAYNE BAY
Cooling Water Discharge
H-1
H-3
H-6
N
J-1
K-2
SCALE IN MILES
0
1/2
1

LOWER FLORIDA ESTUARY STUDY PROJECT

WATER QUALITY SAMPLING STATIONS
1969 & 1970

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

intermittently throughout the survey, with showers during the early morning and early afternoon. Associated cloud cover was quite heavy, generally above 50 percent. Seas were generally choppy but became calm around sunrise and sunset, and rough during squalls.

Highest water temperature occurred at Station H-1-T (500 yards east of Grand Canal). Temperature ranged from 84.0 to 93.5°F and averaged 89.2°F. Near the bottom at this Station (H-1-B), temperature ranged from 84.0 to 89.0°F and averaged 86.2°F. Analysis of the variance about the mean of these two data sets shows that the 3 degree difference is significant and indicates that the bay is thermally stratified at that point. No other station exhibited this degree of stratification (Table 1).

Temperatures at Station H-3 averaged 84.5 and 84.7°F at top and bottom, respectively. At Station H-6, 3000 yards east of Grand Canal, both top and bottom temperatures averaged 84.3°F.

Station E-2 is within the northward path of the heated water plume. Temperatures there were elevated to 88°F with no significant thermal stratification. Analysis of variance of the mean temperature at Stations H-1-S and E-2-S shows that the difference (1°F) is statistically significant. Similarly, the difference between E-2-T and H-6-T (3.9°F) is also significant.

Station J-1 is occasionally within the southern influence of the heated water plume. The temperature curve follows very closely the chloride curve, indicating that on flood tide the heated water is against the shore and expands to the south against its normal north-

TABLE 1

TEMPERATURE, DISSOLVED OXYGEN AND CHLORIDE CONCENTRATION

BISCAYNE BAY AT TURKEY POINT

9/30/69 thru 10/2/69

STATION		TEMPERATURE °F	DISSOLVED OXYGEN mg/l	CHLORIDE mg/l
E-2-T	Max	92.5	8.93	14600
	Min	84.0	5.02	11600
	Avg	88.2	6.45	13000
E-2-B	Max	92.5	9.65	15400
	Min	84.0	3.69	12300
	Avg	88.0	6.42	13400
H-1-T	Max	93.5	7.55	14200
	Min	84.0	4.98	9900
	Avg	89.2	6.05	11900
H-1-B	Max	89.0	7.73	15500
	Min	84.0	4.40	11300
	Avg	86.2	6.26	13200
H-3-T	Max	88.0	8.09	16300
	Min	80.0	5.39	13900
	Avg	84.5	6.55	14800
H-3-B	Max	88.0	8.11	16500
	Min	80.0	5.55	13900
	Avg	84.7	6.63	15300
H-6-T	Max	86.0	7.56	18500
	Min	83.0	5.46	15600
	Avg	84.3	6.25	16700
H-6-B	Max	86.0	6.94	19200
	Min	83.0	5.45	15700
	Avg	84.3	6.19	16700
J-1-T	Max	89.5	8.43	14400
	Min	81.5	5.08	10400
	Avg	85.2	6.51	12400
J-1-B	Max	89.5	8.70	15100
	Min	83.5	4.89	11100
	Avg	85.4	6.64	13900

ward flow pattern. Temperatures at J-1-T and J-1-B averaged 85.2 and 85.4°F, respectively, and were significantly different from those at Station H-1 but exhibited no statistically significant vertical thermal stratification.

At a recording monitor control station away from the influence of elevated temperature, on the southeast side of Arsenicker Key, the maximum temperature was 85°F and the minimum 84°F. The increase in temperature due to the cooling water discharge averaged 4.7°F and the maximum increase was 9°F. Temperature variation 500 yards east of Grand Canal was 9.5°F. Temperature variation at the control location was 1°F.

Concentration of chloride at Station H-1-T was the lowest of any station tested and averaged 11.9 gm/l. Concentration varied widely (9.9 to 14.2 gm/l), probably due to the frequent and locally heavy thunder storms and resultant runoff.

Station E-2-S, located some 1500 yards north and 500 yards east of Grand Canal, had an average chloride level of 13.0 gm/l. Station H-3, 1000 yards east of H-1, had an average of 14.8 gm/l. This reaffirms that water discharged from the canal moves northward along the shore. It also indicates that the less dense heated water, when combined with less dense surface drainage, produces an effluent which does not readily mix with the cooler and more saline waters of Biscayne Bay. This suggests a moderate to low coefficient of turbulent diffusion. Station J-1 also had slightly reduced chloride levels, further supporting this hypothesis.

Station H-3 shows very weak salinity stratification (500 mg/l in 5-foot depth) and Station H-6 had no vertical salinity stratification. There was less than 2.0 gm/l difference between the means of Station H-3 and H-6, indicating a narrower zone of fresh water influence in the easterly direction than in the northerly direction.

The lowest DO reading was 3.69 mg/l at Station E-2-B. The highest value of 9.65 mg/l was also observed at E-2-B. Diurnal variations were observed at all stations. These variations were generally the same magnitude at surface and bottom stations. The diurnal cycle of the DO curve in contrast to the 12.4 hour tidal cycle shows that the DO variations are not strongly related to the tide stage.

Alkalinity remained relatively constant throughout the sampling program. The greatest variation was from Station H-1 to H-3 to H-6. From a mean of 136 mg/l at H-1-T, the alkalinity dropped to 127 mg/l at H-3-T and 118 mg/l at H-6-T. It is interesting to note that alkalinity at H-3-B (118 mg/l) is the same as at H-6-T. This, along with the chloride concentrations, is evidence of some stratification at H-3, probably in the nature of a salt wedge. (Table 2)

The immense buffer capacity of sea water is reflected in the constant pH. Station H-1-T, which has already been shown to be different water from that at other stations, shows a pH of 7.8. This is 0.1 pH unit below the general level of the bay and is not considered a significant factor, especially in the light of the slightly higher alkalinity discussed above.

TABLE 2

SUMMARY OF CHEMICAL DATA

BISCAYNE BAY AT TURKEY POINT

9/30/69 thru 10/2/69

STATION	pH Units	ALKALINITY mg/1	TURBIDITY JCU	AMMONIA mg/1 as N	NITRITE NITRATE mg/1 as N	TOTAL KJELDAHL NITROGEN mg/1 as N	BIOCHEMICAL OXYGEN DEMAND * mg/1
E-2-T	8.0	136	2.2	0.07	0.030	0.27	0.4
E-2-B	8.0	133	2.7	0.07	0.032	0.31	0.6
H-1-T	7.8	136	3.1	0.08	0.023	0.36	0.6
H-1-B	7.9	131	4.8	0.06	0.018	0.36	0.6
H-3-T	7.9	127	2.3	0.06	0.018	0.29	0.6
H-3-B	8.0	118	2.5	0.08	0.019	0.33	0.6
H-6-T	7.9	118	2.4	0.06	0.034	0.23	0.2
H-6-B	7.9	120	2.8	0.06	0.036	0.28	0.6
J-1-T	8.0	136	1.8	0.06	0.010	0.33	0.6
J-1-B	8.0	129	2.6	0.05	0.013	0.33	0.5

* 5 day $20^{\circ}C$

Turbidity was consistently low, having a maximum of 15.0 Jackson Candle Units (JCU) in one sample from Station H-1-B. The highest average value was also at H-1-B (4.8 JCU). The average at that station, disregarding the single high value, was 3.3 JCU.

Combined nitrite and nitrate nitrogen exhibited the highest average concentration at Station H-6-B, with 0.036 mg/l as N. The highest individual concentration was 0.060 mg/l at Station E-2-B at a high tide condition.

Highest values of total Kjeldahl nitrogen occurred at Station H-1. At that station, average concentration--both top and bottom--was 0.36 mg/l as N. At every station, Kjeldahl nitrogen was either the same top-to-bottom or the bottom sample was slightly higher.

Biochemical oxygen demand (5-day, 20°C) was, without exception, extremely low. Maximum observed BOD on an individual sample was 0.7 mg/l.

These data confirm that Lower Biscayne Bay is almost totally free of man-made organic pollution.

A second water quality survey was conducted on January 17, 18 and 19, 1970. Highest temperatures occurred at Station H-1 (Figure 9), ranging from 66.0°F to 79.0°F and averaging 75.5°F for the 48-hour period. Temperatures at Station H-3 averaged 69.0°F, while at Station E-2 they were 71.5, reflecting the northward movement of the heated water plume. Station K-2, south of the mouth of Grand Canal, also shows the influence of heated effluent with a temperature of 70.0°F, both top and bottom. Temperatures at Station H-6, 3000 yards east of Grand Canal, ranged from 66.0°F to 70°F, and averaged 68.0°F (Table 3). Temperature at the monitor control station averaged 70°F. This was 5.5°F less than that observed 500 yards east of the Grand Canal.

Chloride concentrations were generally higher than in the September survey, reflecting the seasonally reduced rainfall and fresh water inflow. Most stations showed 0.2 gm/l or less difference from top to bottom.

Dissolved oxygen was consistently high throughout the sampling period with a minimum value of 4.0 mg/l occurring at Station K-2-B. Maximum values were as high as 9.5 mg/l. There was no significant difference between dissolved oxygen concentrations in the mouth of Grand Canal and in the open bay.

Biochemical oxygen demand was higher during this survey than in the September study. A maximum value of 4.9 mg/l was observed at Station H-6-B. There is no readily apparent explanation for this phenomenon. The distribution does not show any relation to sources of waste. (Table 4)

As in the previous study, all other chemical parameters measured were found in extremely low concentrations. Turbidity had a maximum value of 2 JCU.

It is concluded from these investigations that the water quality of Biscayne Bay as measured by the standard chemical indicators is of extremely high purity and that no pollution is present which might cause damage to the aquatic environment.

TABLE 3

TEMPERATURE, DISSOLVED OXYGEN, AND CHLORIDE CONCENTRATION

BISCAYNE BAY AT TURKEY POINT

1/17/70 thru 1/19/70

STATION		TEMPERATURE °F	DISSOLVED OXYGEN mg/1	CHLORIDE mg/1
E-2-T	Max	74.5	9.5	15800
	Min	68.5	6.1	14300
	Avg	71.5	7.5	14800
E-2-B	Max	74.5	9.5	16300
	Min	68.5	4.8	14200
	Avg	71.0	7.4	14700
H-1-T	Max	79.0	8.4	15900
	Min	66.0	6.0	14100
	Avg	75.5	7.1	14900
H-1-B	Max	79.0	9.4	15700
	Min	66.0	6.1	14100
	Avg	75.5	7.3	14900
H-3-T	Max	71.0	8.4	15700
	Min	66.5	7.1	13800
	Avg	69.0	7.7	14600
H-3-B	Max	71.0	8.6	15800
	Min	66.5	6.8	13800
	Avg	69.0	7.6	14800
H-6-T	Max	70.0	8.5	16300
	Min	66.0	6.0	14900
	Avg	68.0	7.6	15500
H-6-B	Max	70.0	8.6	16700
	Min	66.0	6.8	14700
	Avg	68.0	7.6	15700
K-2-T	Max	73.0	8.8	15100
	Min	68.0	4.6	12300
	Avg	70.0	7.6	13900
K-2-B	Max	72.5	8.6	14800
	Min	68.0	4.0	12600
	Avg	70.0	7.5	13900

TABLE 4

SUMMARY OF CHEMICAL DATA

BISCAYNE BAY AT TURKEY POINT

1/17/70 thru 1/19/70

STATION	ALKALINITY mg/1	TURBIDITY JCU	AMMONIA mg/1 as N	NITRITE NITRATE mg/1 as N	TOTAL KJELDAHL NITROGEN mg/1 as N	TOTAL PHOSPHATE mg/1 as P	BIOCHEMICAL OXYGEN DEMAND * mg/1
E-2-T	150	1	0.02	0.010	0.53	<0.05	1.1
E-2-B	149	1	0.02	0.009	0.34	<0.05	1.7
H-1-T	154	2	0.04	0.016	0.50	<0.05	3.2
H-1-B	153	1	0.02	0.015	0.46	<0.05	1.2
H-3-T	148	1	0.02	0.013	0.44	<0.05	3.4
H-3-B	149	1	0.02	0.011	0.43	<0.05	0.9
H-6-T	141	1	0.05	0.018	0.35	<0.05	3.5
H-6-B	142	1	0.03	0.017	0.36	<0.05	4.9
K-2-T	152	1	0.03	0.009	0.44	<0.05	0.9
K-2-B	154	1	0.02	0.008	0.52	<0.05	0.9

* 5 day 20°C

A water quality survey was conducted in Card Sound on January 15, 1970. Five locations were sampled, top and bottom, at two-hour intervals for a period of fourteen hours (Figure 10).

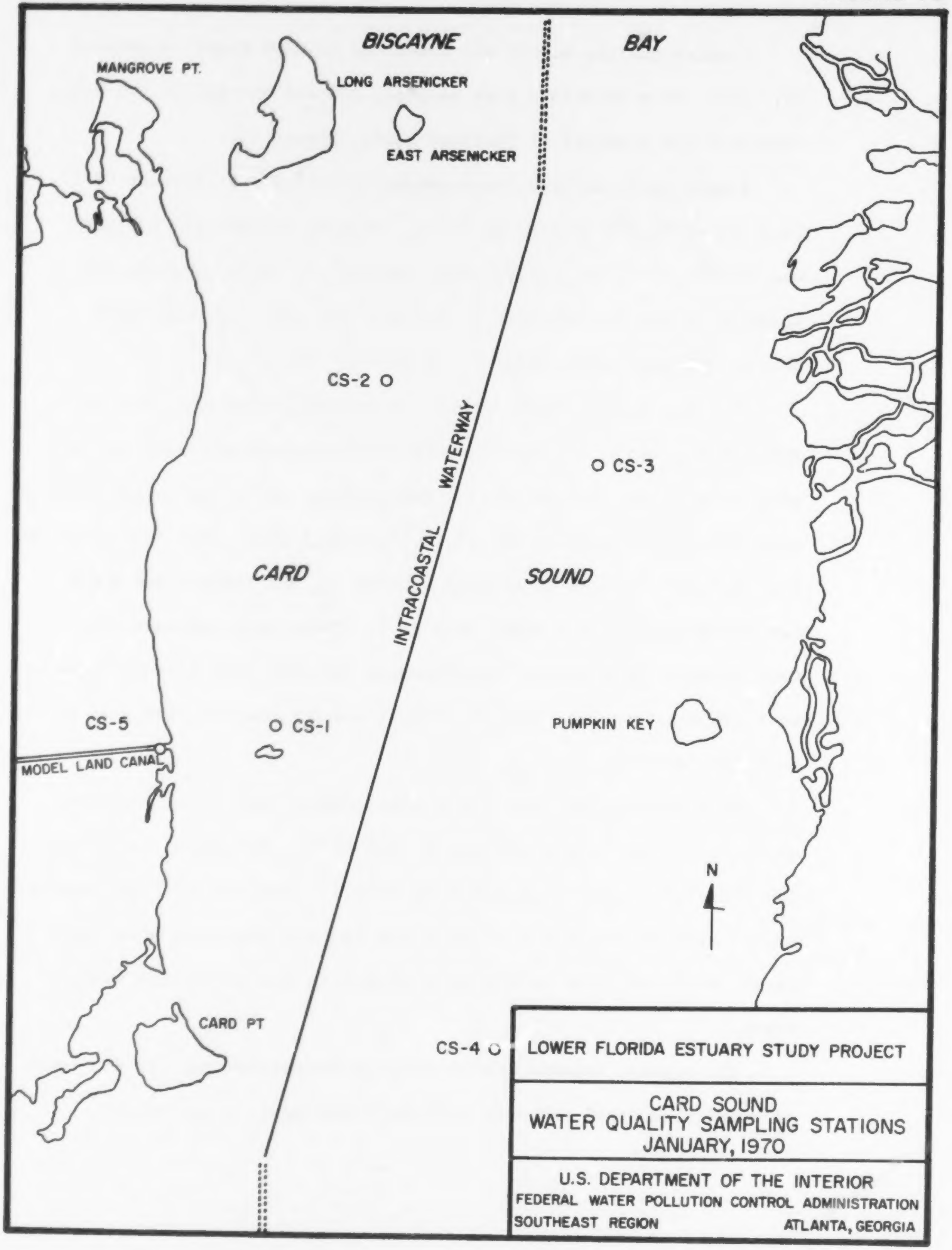
Temperatures in Card Sound ranged from 71.5°F at Station CS-1 to a low of 60.0°F at four stations. Highest average temperature was 66.5°F; also, at Station CS-1. Temperature stratification was apparent at the two stations in and near the mouth of Model Land Canal, with the warmer water lying on top. (Table 5)

Chloride data confirm a two-layered system near the mouth of Model Land Canal. Average chloride concentrations are 13.9 and 14.3 gm/l at Stations CS-5 and CS-1, respectively, while the bottom samples have chloride concentrations of 16.2 and 16.5 gm/l. All other stations show 0.2 gm/l or less difference between top and bottom, and these concentrations are all above 16.0 gm/l. These data indicate that Card Sound is more saline than Biscayne Bay--and this factor, together with the deeper water, provides a more oceanic habitat than that of Lower Biscayne Bay.

Dissolved oxygen levels were consistently high, with a minimum value of 5.0 mg/l and a maximum of 11.5 mg/l. Throughout Card Sound, the dissolved oxygen averaged about 8 mg/l. Weak but distinguishable oxygen stratification was noted at the two stations near Model Land Canal, with the lower values associated with the warmer and fresher water.

The highest ammonia and nitrate concentrations were at the mouth of Model Land Canal and were 0.10 and 0.035 mg/l, respectively.

FIGURE 10


BISCAYNE
BAY
MANGROVE PT.
LONG ARSENICKER
EAST ARSENICKER
CS-2
CS-3
INTRACOASTAL WATERWAY
CARD
SOUND
CS-5
CS-1
PUMPKIN KEY
MODEL LAND CANAL
N
CARD PT
CS-4

LOWER FLORIDA ESTUARY STUDY PROJECT

CARD SOUND
WATER QUALITY SAMPLING STATIONS
JANUARY, 1970

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

TABLE 5

TEMPERATURE, DISSOLVED OXYGEN, AND CHLORIDE CONCENTRATION

CARD SOUND

1-15-70

STATION	TEMPERATURE ^{o}F	DISSOLVED OXYGEN mg/1	CHLORIDE mg/1
CS-1-T	Max 71.5	8.5	16600
	Min 61.0	6.4	10400
	Avg 66.5	7.7	14300
CS-1-B	Max 63.5	9.4	16900
	Min 60.5	5.0	16000
	Avg 62.0	8.0	16500
CS-2-T	Max 63.0	11.5	16700
	Min 60.5	7.5	16000
	Avg 62.0	8.9	16500
CS-2-B	Max 62.0	11.2	17000
	Min 60.0	7.5	16200
	Avg 61.5	8.9	16700
CS-3-T	Max 63.0	8.7	17500
	Min 60.0	8.3	16700
	Avg 61.0	8.5	17000
CS-3-B	Max 62.5	8.5	17300
	Min 60.0	8.1	16000
	Avg 61.5	8.3	16800
CS-4-T	Max 62.0	8.7	17500
	Min 61.0	8.2	16200
	Avg 61.5	8.4	16600
CS-4-B	Max 62.0	8.9	17200
	Min 60.0	8.3	16100
	Avg 61.0	8.5	16600
CS-5-T	Max 68.0	8.9	17200
	Min 61.5	6.6	5800
	Avg 64.0	7.8	13900
CS-5-B	Max 63.5	8.6	16600
	Min 61.5	8.0	14800
	Avg 62.0	8.2	16200

Maximum total Kjeldahl nitrogen of 0.88 mg/l occurred at Station CS-1. All total phosphate concentrations were below 0.05 mg/l. (Table 6)

Turbidity concentrations were 4 JCU maximum at Station CS-5 and generally 1 JCU through the Sound. Alkalinity ranged from 152 to 169 mg/l. Five day BOD in Card Sound showed a maximum concentration of 3.2 mg/l.

From these data, it is concluded that the water quality of Card Sound is excellent and that no pollution is present which might cause damage to the ecosystem of Card Sound.

C. Circulation (Lower Biscayne Bay)

A tracer study was conducted in Biscayne Bay in the vicinity of Turkey Point January 12-13, 1970. The specific purpose of this dye study was to determine the distribution of the FP&L power plant condenser cooling water discharge in Biscayne Bay.

Two hundred fifty pounds of 20 percent Rhodamine WT dye (50# of dye) was instantaneously discharged into Grand Canal at high-water slack (HWS) on January 12. Samples were collected on an hourly schedule at the water surface and bottom at each of 16 stations for the next 24-hour period.

The dye moved very slowly initially, taking approximately 45 minutes to one hour to clear the mouth of the effluent canal (Figure 11). After exiting from the canal, the dye began to rapidly disperse and move northeastward on the ebbing tide. Peak concentrations were found just east of Turkey Point, between high-water and low-water slack conditions. Just after low-water slack conditions, the peak concentrations continued

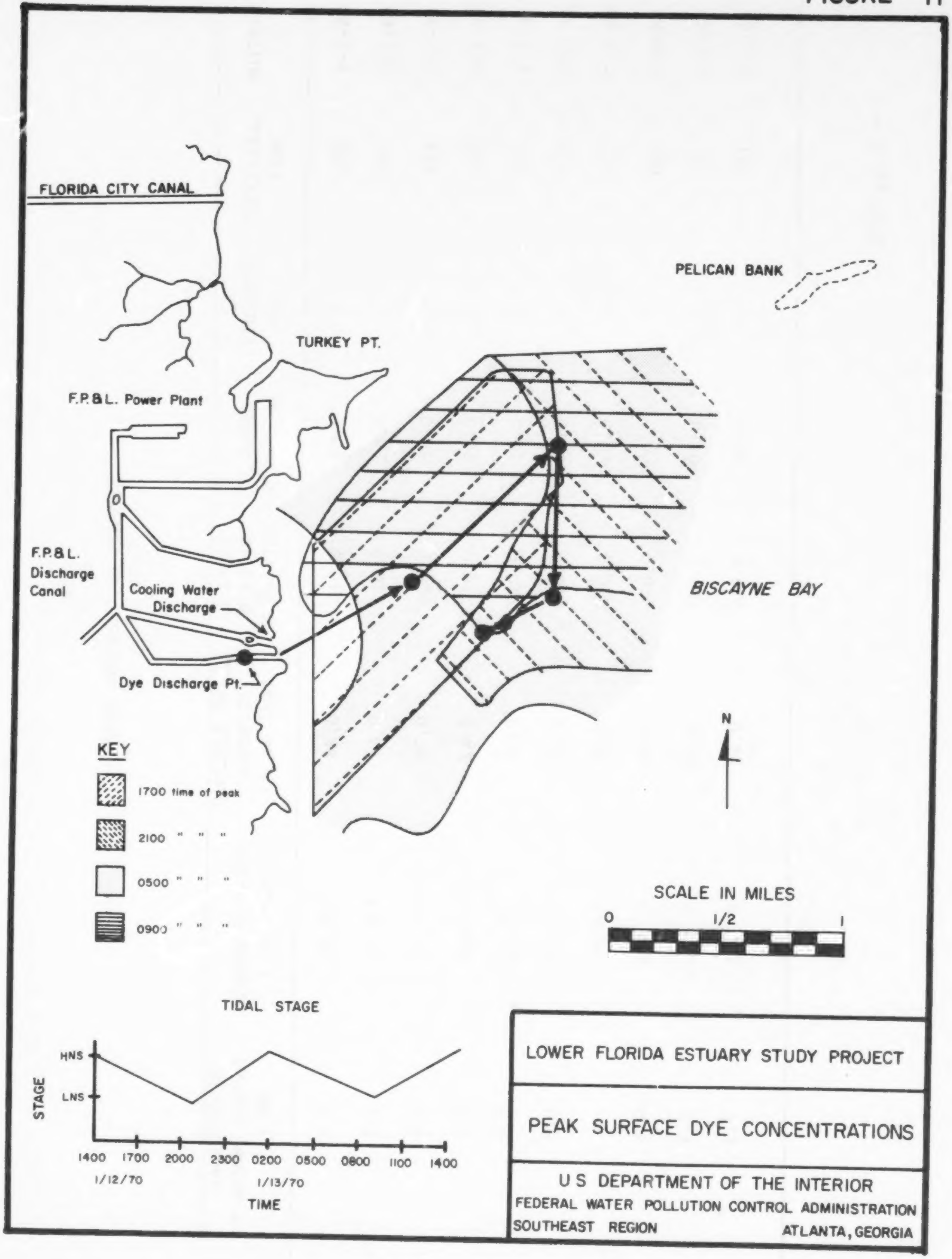
TABLE 6

SUMMARY OF CHEMICAL DATA
CARD SOUND
1/15/70

STATION	ALKALINITY mg/l	TURBIDITY JCU	AMMONIA mg/l as N	NITRITE NITRATE mg/l as N	TOTAL KJELDAHL NITROGEN mg/l as N	TOTAL PHOSPHATE mg/l as P	BIOCHEMICAL OXYGEN DEMAND * mg/l
CS-1-T	164	1	0.03	0.015	0.88	< 0.05	0.2
CS-1-B	154	1	0.03	0.013	0.47	< 0.05	1.3
CS-2-T	153	1	0.08	0.020	0.38	< 0.05	2.4
CS-2-B	154	1	0.03	0.012	0.42	< 0.05	2.2
CS-3-T	152	1	0.05	0.017	0.35	< 0.05	0.8
CS-3-B	152	1	0.04	0.014	0.35	< 0.05	0.6
CS-4-T	154	2	0.04	0.018	0.46	< 0.05	-
CS-4-B	156	1	0.03	0.014	0.26	< 0.05	0.4
CS-5-T	169	4	0.10	0.035	0.53	< 0.05	2.9
CS-5-B	157	2	0.04	0.019	0.44	< 0.05	3.2

* 5 day $20^{\circ}C$

FIGURE 11


FLORIDA CITY CANAL
PELICAN BANK
TURKEY PT.
F.P.& L. Power Plant
F.P.& L. Discharge Canal
Cooling Water Discharge
Dye Discharge Pt.
BISCAYNE BAY
N
KEY
1700 time of peak
2100 " " "
0500 " " "
0900 " " "
SCALE IN MILES
0
1/2
1
TIDAL STAGE
STAGE
HNS
LNS
1400
1700
2000
2300
0200
0500
0800
1100
1400
1/12/70
1/13/70
TIME

LOWER FLORIDA ESTUARY STUDY PROJECT

PEAK SURFACE DYE CONCENTRATIONS

U S DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

to move northeastward. Approximately 1½ hours before HWS (@ 2:38 on 1/13/70), the dye-patch began moving south; two hours and 22 minutes after the HWS, the dye-patch was located approximately 1.1 miles northeast of the mouth of Grand Canal.

The dye, and hence heated water from the FP&L effluent canal, moves northeastward from the canal spreading over a large area of Biscayne Bay adjacent to Turkey Point and is persistent in concentration. The effluent from the canal is slowly dispersed, and is not readily flushed from the area. Thus, any cooling of water in the bay primarily occurs through exchange with the atmosphere rather than by mixing and dilution.

D. Temperature Effects

The Federal Water Pollution Control Administration conducted thermal studies of Lower Biscayne Bay from April to August 1968. This report is included as Appendix A. (6) Monitoring on a reduced scale was continued through the winter, spring and summer of 1968-69. In the late summer of 1969, full-scale thermal studies were again undertaken.

During the April-August 1968 study, a total of ten stations were established, several of which were beyond any possible influence of the heated water effluent. Maximum temperatures at stations close to the discharge canal were from 3° to 9° F higher than at control stations, and statistical analysis showed that these differences were significant and not merely the result of natural diurnal variation.

Furthermore, the daily fluctuations in temperature were much greater at the stations near Grand Canal than at the control stations. Two control stations (C-6 and E-9) had maximum daily temperature fluctuation of 3° to 4°F, while two stations near Grand Canal (H-13-A and H-14) had maximum daily fluctuations of 9° and 7°F, respectively.

The maximum hourly rate of temperature change was found at stations H-13-A and H-13 and amounted to 3°F per hour.

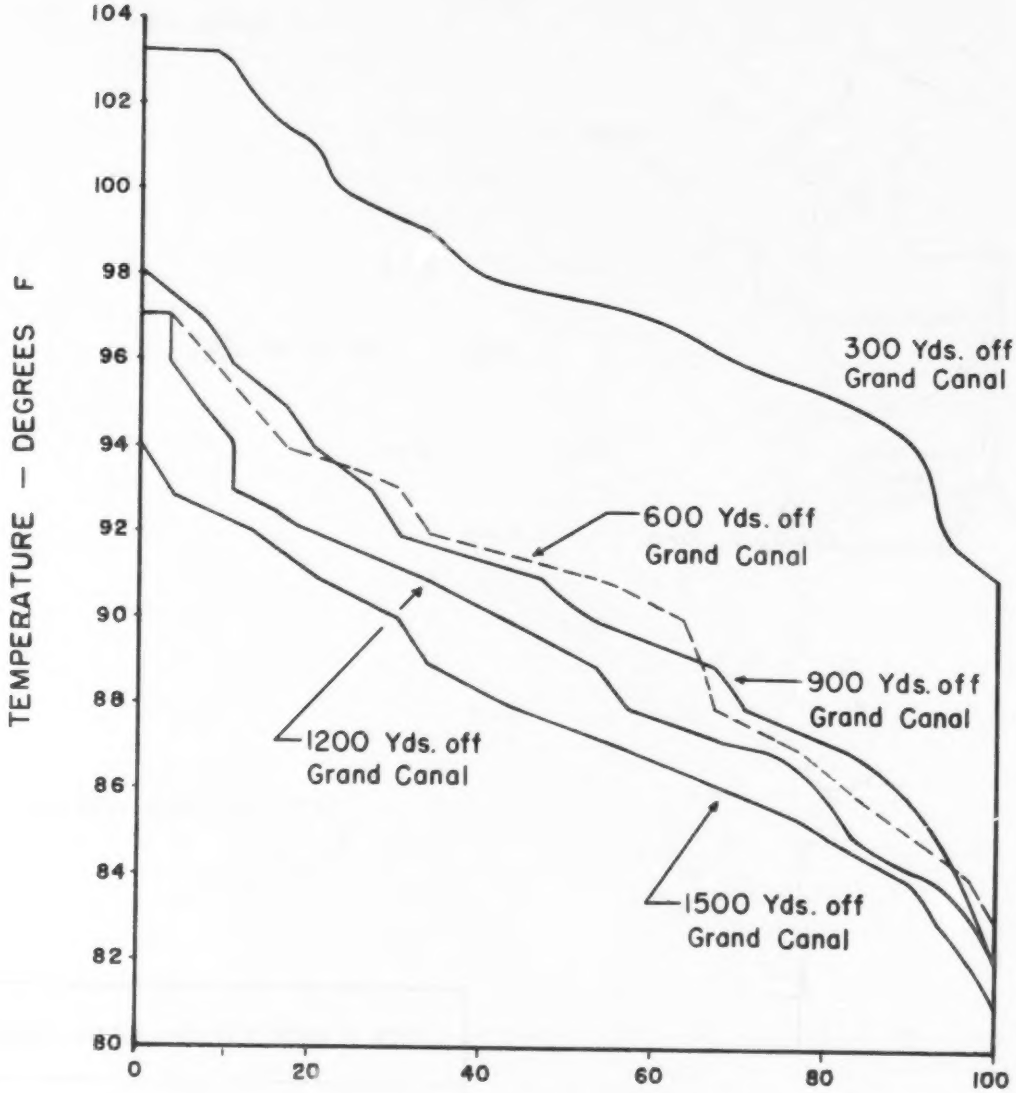
Numerous isotherm plots under various wind and tide conditions indicated that the movement of the heated water was in a generally northeasterly direction around Turkey Point.

A critical temperature condition occurred in June 1969. Figure 12 shows the percent of the time the temperature equalled or exceeded various levels at each of two stations along a 75° transect from Grand Canal. At 300 yards, the maximum daily temperature equalled or exceeded 90°F on all days. The maximum daily temperature observed was 103°F. At 1200 yards off Grand Canal, the maximum daily temperature exceeded 90°F on 43 percent of the days and reached a maximum of 97°F. These maximum temperatures resulted in a massive fish kill which will be described in subsequent sections.

The first full month for which data are available from the present temperature monitoring program is August 1969. Figure 13 shows the location of the automatic monitors. Temperatures as high as 95°F occurred up to 1000 yards east and 1500 yards north of Grand Canal. The isotherms of the monthly mean of the daily maximum temperature

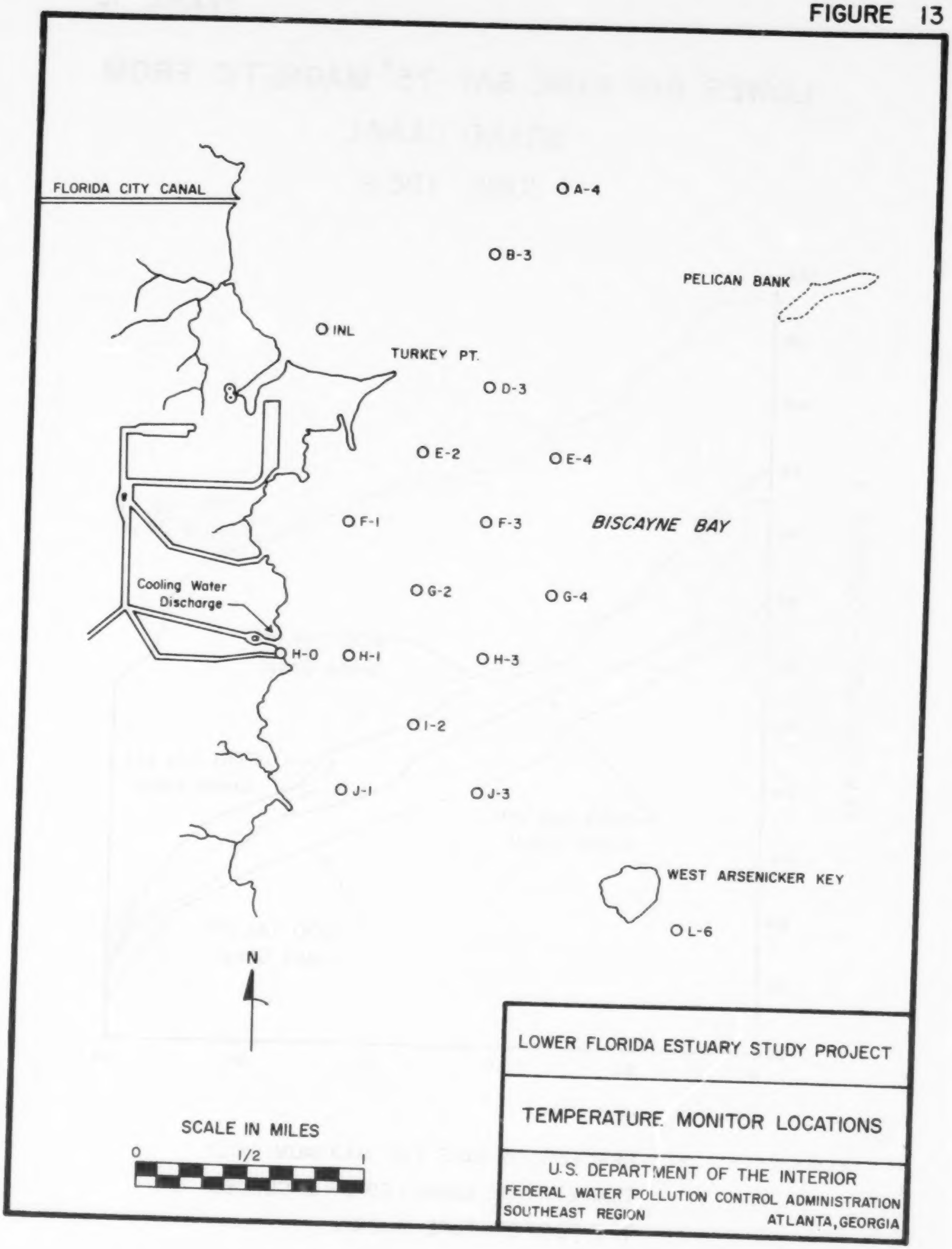
FIGURE 12

LOWER BISCAYNE BAY 75° MAGNETIC FROM GRAND CANAL
JUNE 1969



PERCENT OF DAYS THE MAXIMUM DAILY TEMPERATURE EQUALLED OR EXCEEDED THE TEMPERATURE SHOWN.

FIGURE 13


FLORIDA CITY CANAL
O A-4
O B-3
PELICAN BANK
O INL
TURKEY PT.
O D-3
O E-2
O E-4
O F-1
O F-3
BISCAYNE BAY
Cooling Water Discharge
O G-2
O G-4
O H-0
O H-1
O H-3
O I-2
O J-1
O J-3
WEST ARSENICKER KEY
O L-6
N
SCALE IN MILES
0
1/2
1

LOWER FLORIDA ESTUARY STUDY PROJECT

TEMPERATURE MONITOR LOCATIONS

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

indicates that the 90°F isotherm extends 1000 yards east, 1000 yards south and to the shores of Turkey Point on the north, or an area of at least 620 acres (Figure 14).

The isotherm field of temperatures which were equalled or exceeded 10 percent of the time during August 1969 indicates that a temperature of 90°F was exceeded throughout an area of over 620 acres (Figure 15).

The observed monthly maximum temperature isotherms for August 1969 (not necessarily simultaneous occurrence) indicate that, in the affected area, temperatures were in excess of 92°F and were as high as 99°F (Figure 16).

Temperatures were also measured at the cooling water intake location north of Turkey Point. The mean temperature during August 1969 was 85.5°F. The mean of the maximum daily temperature was 86.0°F. The maximum temperature observed during August 1969 was 88°F.

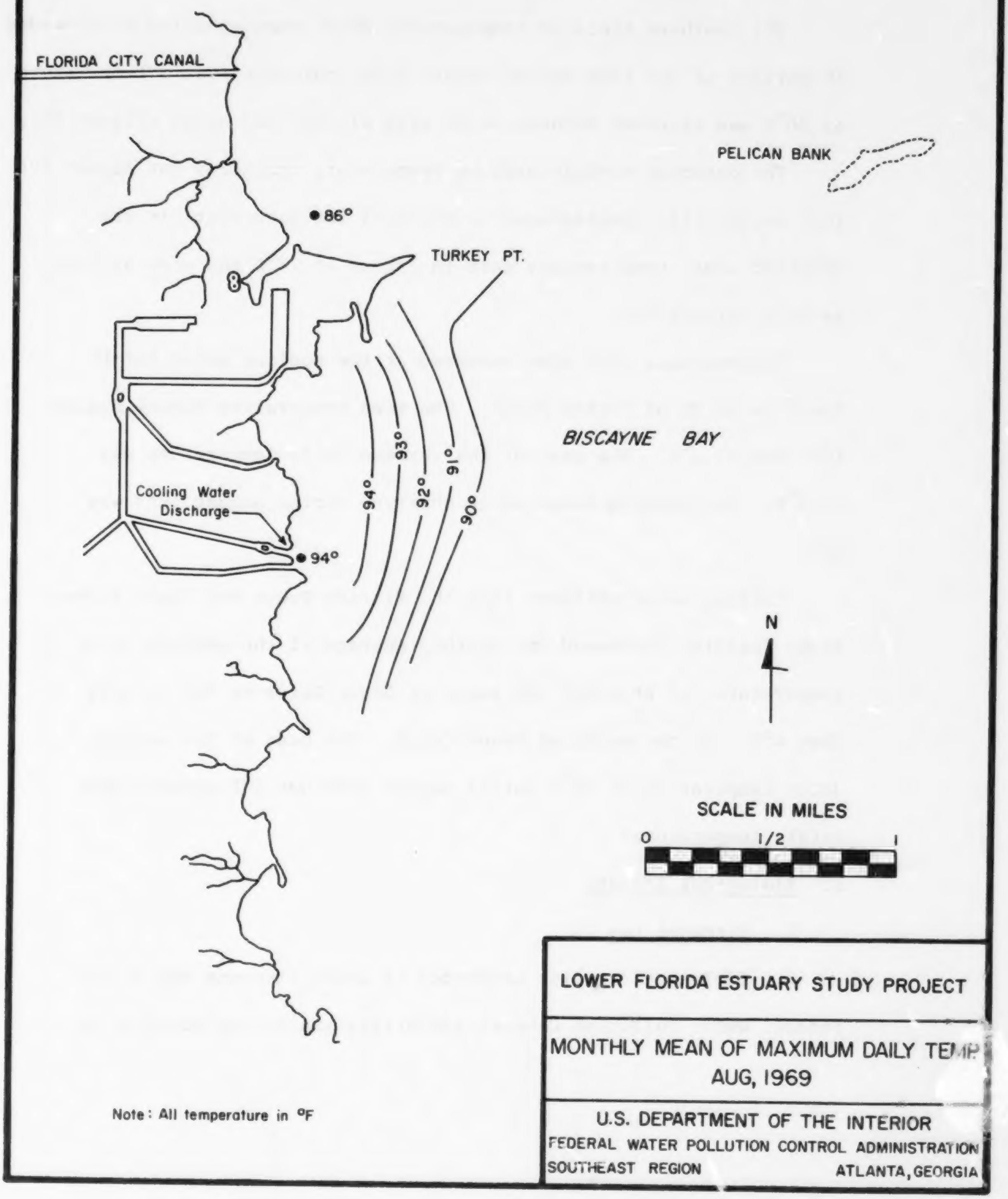
Cooling water effluent from the Florida Power and Light Turkey Point facility increased the monthly average of the maximum daily temperatures of at least 620 acres of Lower Biscayne Bay by more than 4°F. At the mouth of Grand Canal, the mean of the maximum daily temperature of 94°F during August 1969 was 8°F greater than intake temperature.

E. Biological Effects

1. Biscayne Bay

Biological studies conducted in Lower Biscayne Bay by the Federal Water Pollution Control Administration in the vicinity of

FIGURE 14

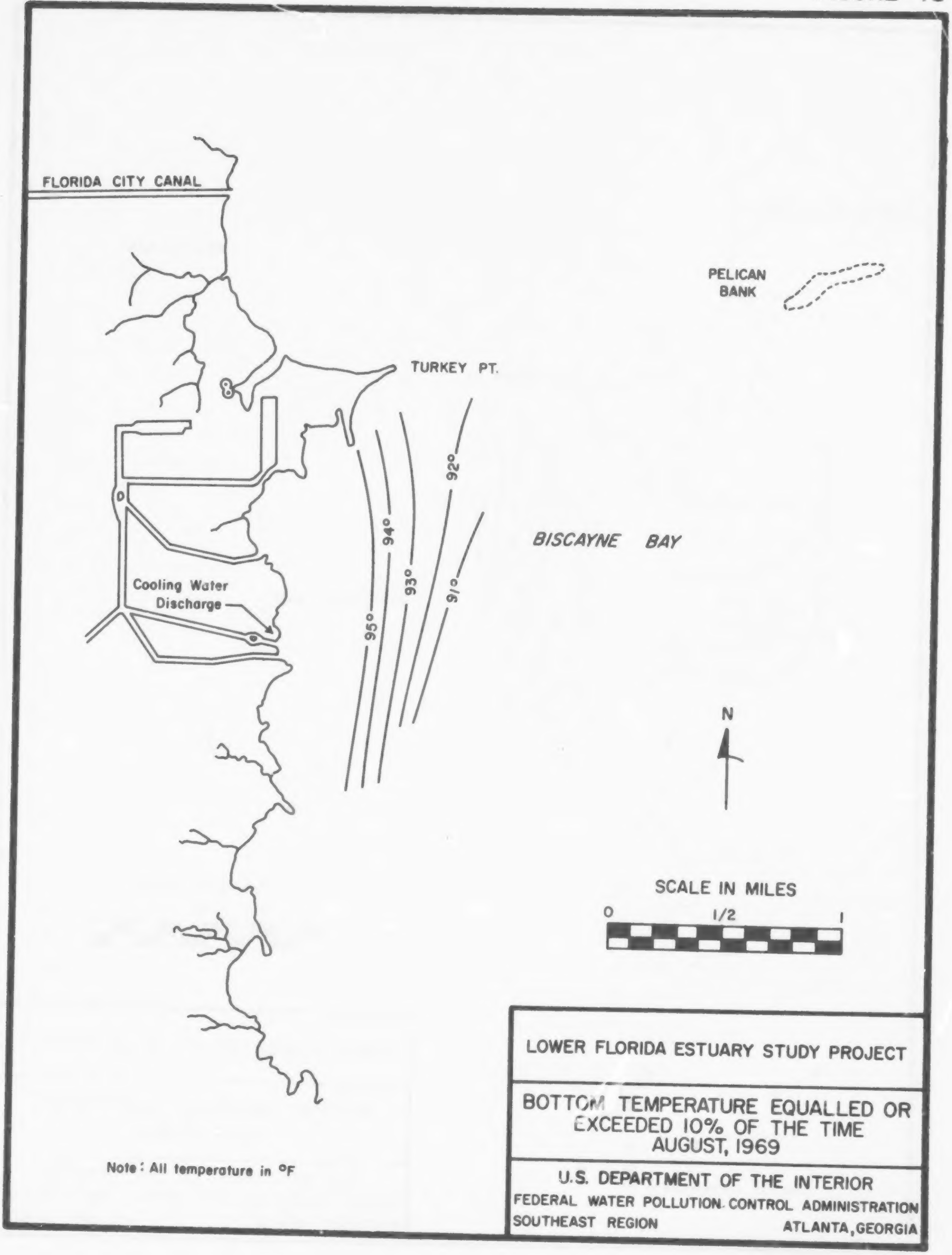

FLORIDA CITY CANAL
PELICAN BANK
86°
TURKEY PT.
BISCAYNE BAY
94°
93°
92°
91°
90°
Cooling Water Discharge
94°
N
SCALE IN MILES
0
1/2
1
Note: All temperature in °F

LOWER FLORIDA ESTUARY STUDY PROJECT

MONTHLY MEAN OF MAXIMUM DAILY TEMP.
AUG, 1969

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE 15


FLORIDA CITY CANAL
PELICAN BANK
TURKEY PT.
BISCAYNE BAY
Cooling Water Discharge
95°
94°
93°
92°
91°
N
SCALE IN MILES
0
1/2
1

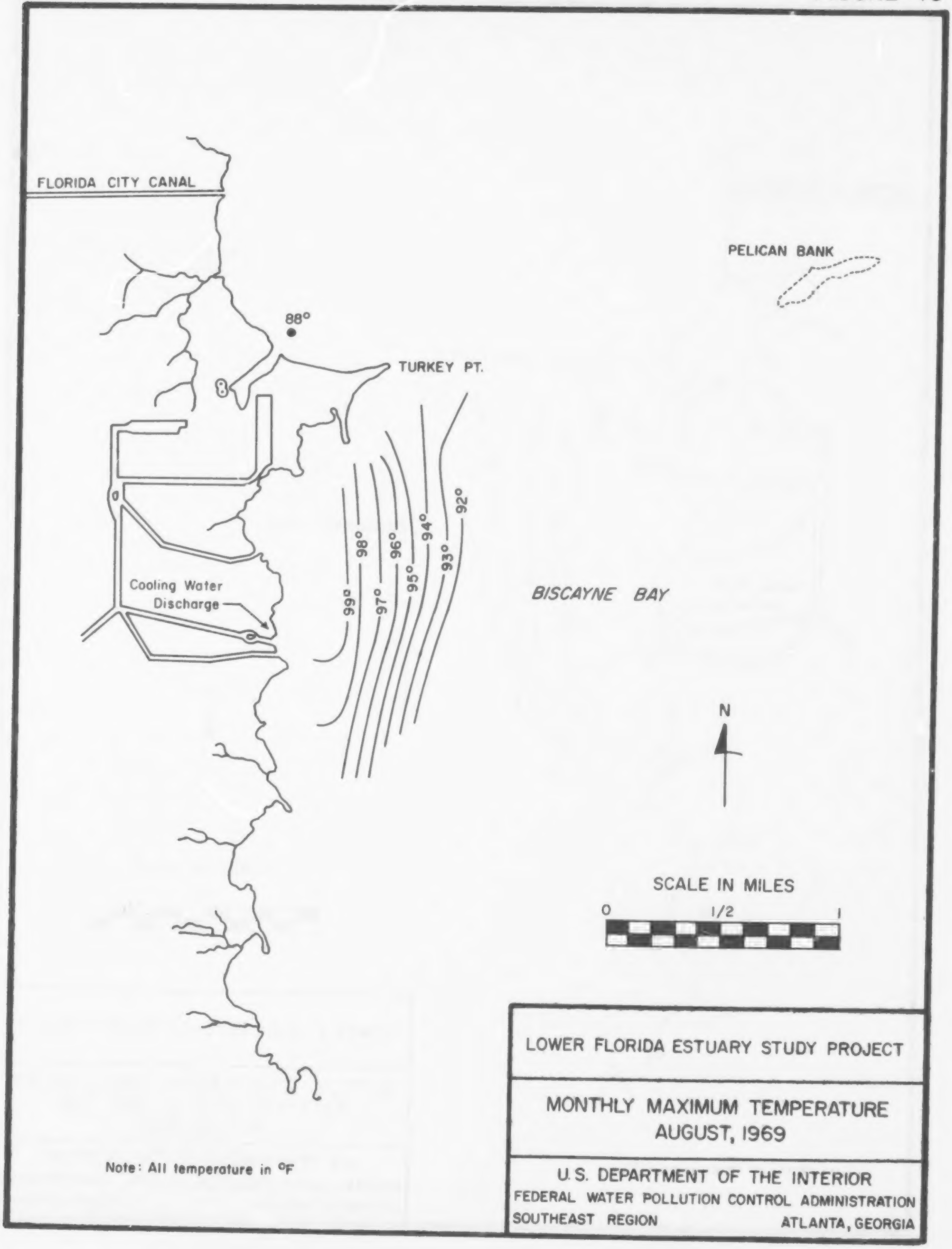
Note: All temperature in °F

LOWER FLORIDA ESTUARY STUDY PROJECT

BOTTOM TEMPERATURE EQUALLED OR EXCEEDED 10% OF THE TIME AUGUST, 1969

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

FIGURE 16


FLORIDA CITY CANAL
PELICAN BANK
88°
TURKEY PT.
99°
98°
97°
96°
95°
94°
93°
92°
Cooling Water Discharge
BISCAYNE BAY
N
SCALE IN MILES
0
1/2
1

Note: All temperature in °F

LOWER FLORIDA ESTUARY STUDY PROJECT

MONTHLY MAXIMUM TEMPERATURE
AUGUST, 1969

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

Florida Power and Light's Turkey Point power plant were initiated during late July 1968.

a. 1968

Near the mouth of Grand Canal, a barren, lifeless zone of denuded sediments extending several hundred yards into the bay was noted. Closer inspection revealed that the denuded sediments were covered with what appeared to be irregular mats of green or bluegreen microalgae. There were, however, none of the rooted plants or attached benthic algae that dominate the subtidal aquatic vegetation common to similar areas of the bay where sediments or sufficient depth exist. The area of barren sediment extended from 200 to 300 yards into the bay in the shape of a lopsided fan, covering an area estimated at 8 to 10 acres.

By late November 1968, an extension of the desolate area and marked erosion of exposed, unconsolidated bay sediments had occurred. Depressions within the affected area were filled with mangrove peat and decomposed *Thalassia* rhizomes, attesting to erosion deep into the soft sediments by swift currents at the mouth of Grand Canal. The area of denuded and seriously eroded sediments had increased in area to an estimated 40 to 50 acres. The soft, rich upper sediment layers were totally removed leaving the more consolidated mangrove peat, and in places, a layer of sand derived from dredging the canal.

Beyond the stark barren zone, in line with Grand Canal and well within the plume of heated water issuing from Grand Canal, a *Thalassia* bed was marked during mid-September which appeared unhealthy.

Upon closer inspection, the turtle grass blades were found to be coated with a heavy gelatinous material composed partly of epiphytic growths. Most of the grass blades had lost their bright green color, their vigor, and appeared brown and lifeless. Dead leaves cast from the plants littered the sediments. Benthic algae and invertebrates common to grass beds unaffected by heated effluents were conspicuously absent from the area characterized by sick and dying grass. Control study areas in nearby turtle grass beds were found to harbor swarms of small forage fish, molluscs, hermit crabs, estuarine corals, and crustacea living within the grass bed, in and upon the sediment, and upon the Thalassia blades as well. In addition, a variety of sessile green algae and mats of drifting red algae carpeted the bay bottom in unaffected areas.

By mid-November 1968, the sickened grasses observed earlier had completely succumbed and been carried away, leaving the exposed sediments which had begun to erode. An underwater search of an area 500 yards offshore from the mouth of Grand Canal showed that few living plants remained and that none of the usual invertebrate animals populating "grass bed" environments remained. A zone of nearly complete destruction of the plant and animal life extended from the mouth of Grand Canal into the bay for 500 to 700 yards, affecting an overall area of about 100 acres. Beyond the limits of the area grossly affected by the heated effluents, extending to between 700 and 1000 yards offshore from Grand Canal, there was a transition zone characterized by varying degrees of damage. It is estimated that the total affected area, including the outer areas evidencing at least a moderate degree of damage, encompassed some 300 acres (Figure 17).

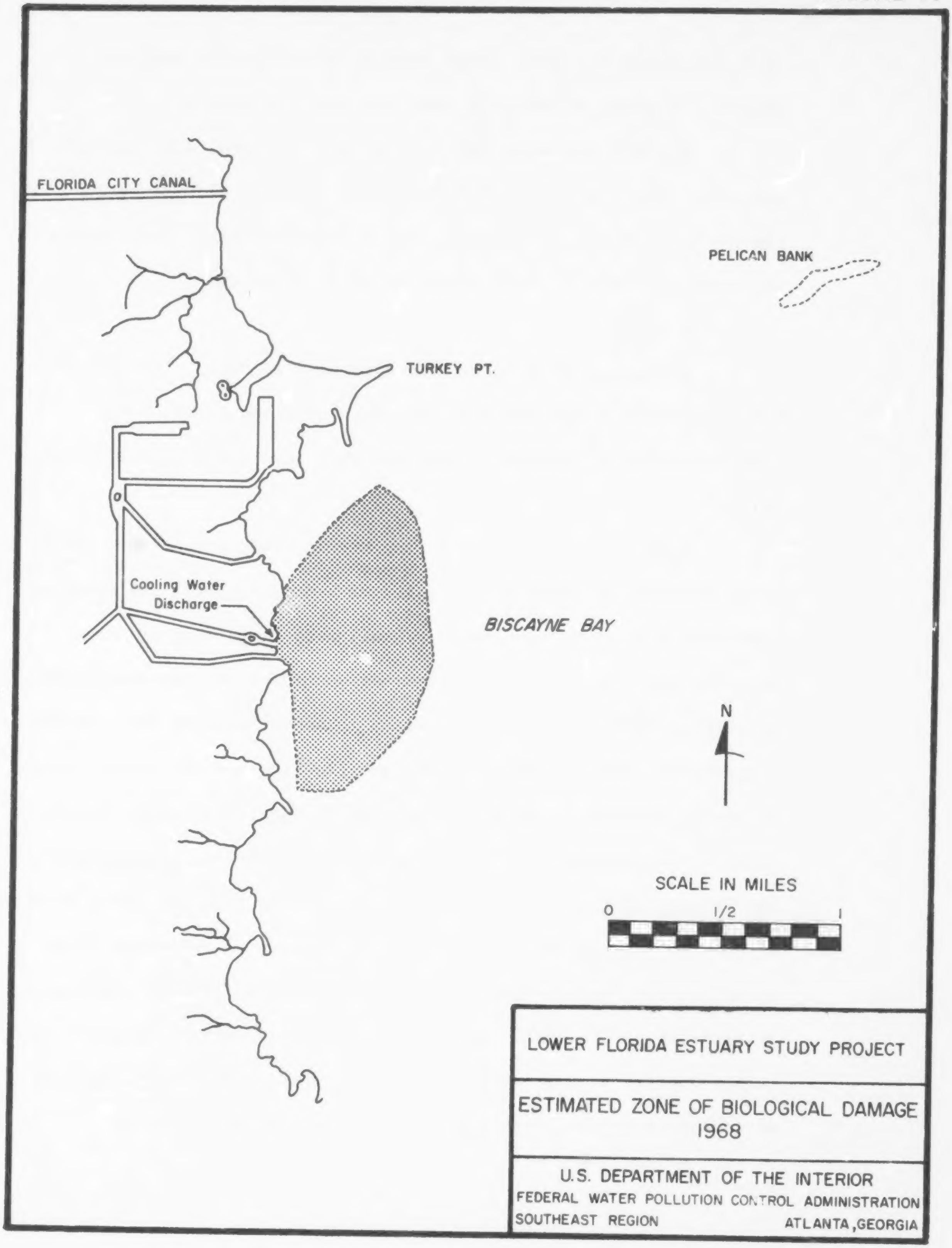
In early February 1969, the previously denuded and eroded sediments were covered by diatom growths, patches of Diplanthera, the hardy green algae Batophora, and a few red algae. There were few remains of the previous inhabitants of the area.

b. 1969

Biological studies in 1969 commenced on May 1. A transect was established extending from the mouth of Grand Canal, E-NE (approximately 75° magnetic) into Biscayne Bay, a distance of 1500 yards.

Observations recorded during May and June showed that while areas outside the immediate vicinity of heated effluent influence had experienced a spring re-growth, a small area of perhaps 10 acres near the mouth of Grand Canal remained devoid of the characteristic near shore benthic communities common to South Biscayne Bay. Aerial photographs taken during mid-June 1969 clearly show the stark, barren sediments, pockets of mangrove peat and Thalassia rhizomes, the calcareous sands washed from Grand Canal, and patches of Diplanthera at the fringes of the bald area. Traces extending from the canal bayward were cut by boat propellers followed by erosion of sediments along the disturbed track. These observations were verified by underwater examination of the area. Underwater exploration also revealed a rock rubble habitat at the mouth of the canal where stone crabs (Menippe mercenaria) and blue crabs (Callinectes sapidus) had taken up

FIGURE 17


FLORIDA CITY CANAL
PELICAN BANK
TURKEY PT.
Cooling Water Discharge
BISCAYNE BAY
N
SCALE IN MILES
0
1/2
1

LOWER FLORIDA ESTUARY STUDY PROJECT

ESTIMATED ZONE OF BIOLOGICAL DAMAGE
1968

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

residence. The exposed sediments near the mouth of the canal were colonized by green and bluegreen micro-algae and alternately by prolific growths of diatoms. The dominant form colonizing the sediments during May and June 1969 was identified as the green algae, Boodleopsis pusilla. The sediment situation was critical since micro-algae possess little ability to bind sediments, thereby protecting them from erosion by wave action and currents.

Mixed with the Diplanthera fringe at the outer edges of the barren zone were populations of Acetabularia crenulata and Batophora oerstedi, robust green algae that had re-established themselves during the cooler winter months. Beyond the fringe, at the 400-yard marker, a sparse growth of turtle grass (Thalassia testudinum) had developed from rhizomes that had been protected deep in the bay sediments. In addition to the Thalassia were a few sessile green algae of the genera Halimeda, Penicillus and Cladophoropsis; a few small coral colonies (Siderastrea sp.); chicken liver sponges, and a few other invertebrate animals. Thalassia re-growth at 400 yards was quite sparse; while at 500 yards, re-growth had become somewhat more dense. Progressively better colonization occurred with greater distance from the mouth of Grand Canal. Thus, the area between the 400-yard marker and the 1200-yard marker along the 75° transect was characterized by a gradient of increased density and diversity of both plant and animal life. Within this zone of re-growth, a host of tiny immature crabs (several genera and many species represented), shrimp, a wide variety of molluscs, pistol shrimp (species of the genus Alpheus), corals (Siderastrea sp.), sessile green algae (species of the genera Halimeda, Penicillus, Caulerpa, Udotea, Cladophoropsis), hermit crabs, small bottom fish, sponges, and the ubiquitous red algal mat, had re-established sizeable populations.

Outside the 500-yard marker, the characteristics of the bay floor undergo a transition from the uniformly deep organic-rich near-shore sediments to an area where sediments blend alternately with an exposed limestone base covered lightly with shell fragments and calcareous sand. On the outer edges of this zone, and on further into the mid-portions of southwest Biscayne Bay, deep sediments are confined to roughly circular pockets, perhaps 100 feet in diameter. These pockets of sediment are invariably dominated by turtle grass (Thalassia testudinum), mixed with smaller densities of sessile green algae. The surrounding lightly-sedimented limestone base supports a wide variety of attached plants and animals, including numerous types of sponges, corals, a wide variety of algae, gorgonians, brittle stars, tiny starfish, burrowing crustacea and worms, limpets, a multitude of molluscs, including many types of clams, snails, mussels, worm shells and scallops, as well as burrow-dwelling fish, and hermit crabs.

On June 5, 1969, changes in benthic populations were being noted in the areas affected by heated effluents from Grand Canal. Even though small fish, shrimp, crabs, amphipods, brittle stars, etc., were noted as close as 200 yards to the outfall, the coral colonies (Siderastrea sp.) had all expired at 400 yards and 600 yards, and some were dead at 800 yards. In addition, a temperature inversion was noted; that is, warmer water was lying on the bay bottom. By June 19, 1969, other species were disappearing, particularly at the inshore stations. The Thalassia bed at 600 yards had begun to lose its green color and was being coated by a brown gelatinous material. Some of the macro-algae had died at 800 yards; 50 to 70 percent of the corals were dead; the Thalassia was coated and epiphytiaed. At 1000 yards, an increasingly large percentage of the Thalassia blades were losing color and vigor. No noticeable problems were observed beyond 1000 yards.

On June 25, unusually turbid waters and concomitant high temperatures were noted. On June 27, the bay bottom along the transect was searched and numerous dead pistol shrimp, blue crabs, spider crabs, dead algae, stone crabs, and molluscs were found. Dead animals were particularly numerous shoreward from the 1000-yard marker. On June 28, the bay bottom from 1500 yards along the transect to the mouth of Grand Canal was thoroughly searched. The bay bottom was littered with dead plants and animals, including sponges, spider crabs, blue crabs, corals, pistol shrimp, clams, snails, mussels, and several varieties of fish in addition to the wilted and browned green algae, species of the genera Anadyomene, Udotea, Penicillus, Halimeda, Caulerpa, Rhizocephalus, Cladophoropsis and Dictyosphaeria.

Within the mouth of Grand Canal, the dead remains of from 30 to 50 stone crabs and blue crabs were found. Outside the mouth of the canal and to the 500-yard marker, blue crabs, stone crabs, pistol shrimp, and a variety of gastropod molluscs dominated the dead animals found. Beyond the 500-yard markers, were found dead sponges (including species of the genera Ircinia and Spheciospongia), a variety of dead sessile green algae, including species of the genera Caulerpa, Udotea, Penicillus, Halimeda, and Anadyomene; dead molluscs included the cross barred venus (Chione cancellata), prickly cockle (Trachycardium egmontianum), banded tulip (Fasciolaria hunteria), true tulip (Fasciolaria tulipa), calico bay scallops (Aquipecten gibbus), worm shells (Vermicularia spirata), limpets (Acmaea sp.), and others; killed crustacea included the previously mentioned pistol shrimp, blue crabs, and stone crabs. Thousands of dead fish were reported south of Turkey Point on June 26, 1969.[2/]

To determine the magnitude of the area of bay bottom affected and to assess the degree of damage caused by the overheating of the bay during late June, a grid pattern of study sites located at 500-yard intervals was plotted on a map to include the portions of Biscayne Bay in the vicinity of Turkey Point affected by heated discharges. A thorough underwater examination, corresponding to the sites in the bay plotted on the map during July 1969 revealed severe damage to benthic plant and animal populations, including corals, sponges, sessile green algae, crustacea, and molluscs in an area extending 1000 yards east, 1000 or more yards north and 500 or more yards south from the mouth of Grand Canal. An area evidencing a moderate degree of damage to benthic inhabitants extended east-

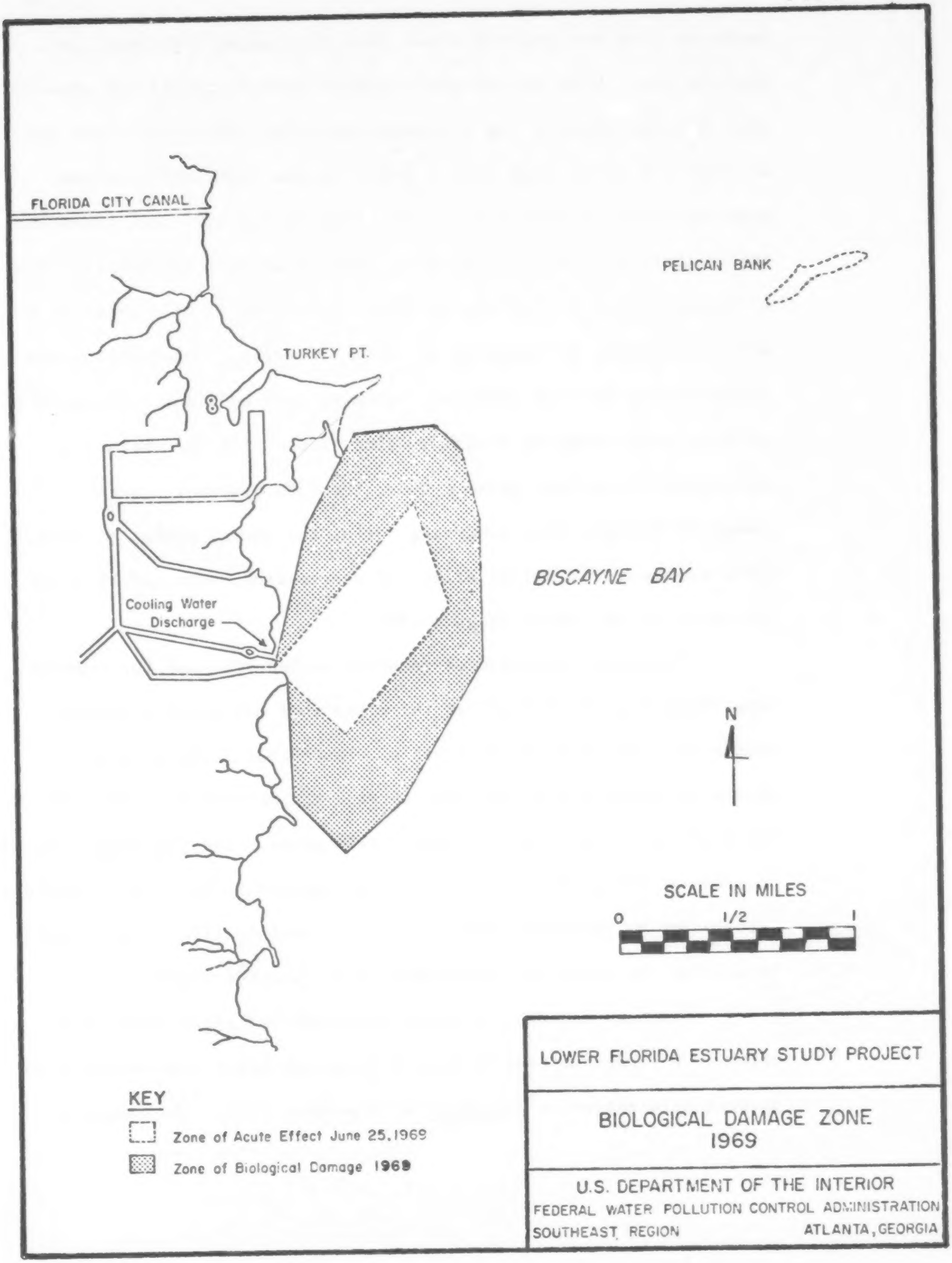
---

[2/] Personal communication, M. A. Roessler, Institute of Marine Sciences northeast from the mouth of Grand Canal to a point 1500 yards into Biscayne Bay. Dead and seriously damaged benthic plants and animals were observed along a line extending more than 1500 yards north and at least 500 yards south from a point located 1000 yards due east from the mouth of Grand Canal. The shape of the kill zone resembled the isotherm diagrams depicting the predominantly northeasterly flow of heated effluents past Turkey Point. The June 25 kill affected an area of Biscayne Bay totaling at least 570 acres. Observations conducted during mid- and late-July revealed that additional damage had occurred south from the mouth of Grand Canal which encompassed an additional 100 or more acres. Thus, the total estimated area of damage in Biscayne Bay, occurring during the summer months of 1969, based solely on the lethal effect of overheating, amounted to about 670 acres of bay bottom (Figure 18).

Excessive temperatures recorded on June 25--and for several days thereafter--killed all of the crabs that had taken residence within the rock pile at the mouth of Grand Canal. The hardier plants occupying the fringe zone outside the denuded sediments off the mouth of Grand Canal were again eliminated. The Thalassia that had re-grown at 500 yards was subject to a complete re-kill, with complete defoliation by September 1969. All other benthic life forms commonly inhabiting the grass bed environment were likewide absent.

Stations located 500 yards north and 500 yards south of a point 1000 yards due east of Turtle Point exhibited approximately 50 percent defoliation of Thalassia by September 1969. The commonly

FIGURE 18


FLORIDA CITY CANAL
PELICAN BANK
TURKEY PT.
BISCAYNE BAY
Cooling Water Discharge
N
SCALE IN MILES
0
1/2
1
KEY
⬚ Zone of Acute Effect June 25, 1969
▨ Zone of Biological Damage 1969

LOWER FLORIDA ESTUARY STUDY PROJECT

BIOLOGICAL DAMAGE ZONE
1969

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

associated sessile green macro-algae were sparse or absent; the vast majority of coral colonies were dead, and the benthic invertebrate population (snails, clams, sponges, etc.) was drastically reduced. The empty shells of killed molluscs littered the substrate; particularly noticeable were the shells of the small mussel Brachidontes exutus and the worm shell, Vermucularia spirata. Both of these species had become unusually abundant at inshore stations prior to the occurrence of excessive summer water temperatures. A large population of common intertidal scavenger snails (i.e., Nassarius vibex and Prunum apicinum), which had presumably responded to an increased food supply brought about by the demise of other species at centrally located study sites, was likewise appreciably reduced by excessive bay water temperatures. There were few species, and a small number of individuals, making up this surviving population that remained viable at these study sites.

At sampling sites located 1500 yards north and 1500 yards south from the mouth of Grand Canal and 1000 yards from shore, the skeletal remains of killed invertebrates were evidence of earlier damage. In some instances, however, there was partial re-growth of new living sponge tissue upon the skeletal remains. Some genera of sessile green macroalgae (i.e., Penicillus and Halimeda) had initiated new growth during late August and early September, whereas others were sparse, rare, or totally absent.

There was progressively less evidence of damage at stations 1500 yards east from the mouth of Grand Canal and at stations north and south from that point. Only the green macroalgae, *Caulerpa paspaloides*, *Caulerpa sertularoides*, *Udotea flabellum* and *Udotea congultinata*; the most sensitive sponges; the corals *Siderastrea sp*. and *Solenastrea hyades*; and certain common molluscs, i.e., *Vermicularia spirata* and *Brachidontes exutus*,were among those constituting the most dependable indicators of thermal stress and damage. Stations outside the area of thermal stress were inhabited by spiny lobsters (*Panulirus argus*), a large variety of swimming crabs, species of the genera *Callinectes* and *Portunus*, stone crabs, spider crabs, pistol shrimp (*Alpheus*), brittle stars (class, *Ophiuroidea*), tiny starfish (*Echinaster sentus*), a host of molluscs, sea anemonae, gorgonids, and all the other life forms comprising the normal flora and fauna of an undistrubed habitat common to Lower Biscayne Bay.

Degradation and destruction of bottom fauna and fish were observed in Lower Biscayne Bay in an area of 300 acres during 1968 and 670 acres during 1969. The area of biological degradation coincides with the observed area of increased water temperatures. During August 1969, water temperatures in the area of biological degradation were from 4°F to 8°F greater than the monthly mean of the maximum daily temperatures at the cooling water intake. Water quality indicators, other than temperature, demonstrate excellent conditions. The cause of the biological degradation and destruction during 1968 and 1969 in Lower Biscayne Bay is the discharge of waste heat from the Florida

Power and Light Company Turkey Point generating plant. The water quality standards of the State of Florida require no damage to aquatic life or vegetation as the result of increased temperature. This criterion is being violated by the discharge of cooling water from the Turkey Point generating plant.

2. Card Sound

A preliminary biological reconnaissance of Card Sound was conducted during late September 1969. Eight sites were selected at intervals across the south end, middle, and north end of the Sound. Two other sites near the mouth of Model Land Canal had been visited previously during the course of servicing thermographs.

The substrate of Card Sound is variable, with sand and shell dominating some areas and accumulations of soft sediments dominating other areas, with a blending of these into mixed sediment types between. As in Biscayne Bay, pockets of sediment are found isolated by a more solid substrate. These sediment pockets support a lush and varied flora, dominated by Thalassia.

A wide variety of benthic plants and animals was noted, including algae, species of the genera Caulerpa, Udotea, Halimeda, Penicillus, Rhipocephalus, Batophora, Acetabularia, Anadyomene, a host of red algae varieties that carpeted the substrate in many areas. There were corals, species of the genera Porites, Solenastrea and Siderastrea, gorgonians, sea anemonae, colonial tunicates, an abundance and wide variety of sponges, sea urchins, species of the genera Diadema and *Lytechinus*, a number of molluscs, including bay-scallops and pen shells. Most conspicuous, however, were the empty mollusc shells littered about the dens of the stone crabs. Stone crabs (*Menippe mercenaria*) and the spiny lobster (*Panulirus argus*), both valuable commercial species, were abundant where suitable cover prevailed. Also found were sea horses, spider crabs, terebellid worms, and mounds presumably thrown-up by burrowing shrimp.

There was a variety and abundance of the green alga *Caulerpa*. *Caulerpa prolifera*, *C. mexicana*, *C. paspaloides*, *C. sertularioides*, *C. cupressoides*, *C. racemosa* and *C. ashmeadii* were all found in abundance in the southeast corner of Card Sound. There was *C. paspaloides* and *C. sertularioides* throughout Card Sound in abundance.

From the biological population composition, it appears that Card Sound is more marine in character than Biscayne Bay and that it is a more stable habitat physically and chemically--less prone to extremes. There appears to be greater *Thalassia* cover in Card Sound as a whole than in south central Biscayne Bay. Although sediment depths are not great, there is sediment of sufficient depth in much of the Card Sound basin to permit luxurious *Thalassia* bed development. A report prepared for Florida Power and Light determined sediment depths at 32 stations in Card Sound. (7) Seventeen of these stations, or nearly 50 percent, had sediment depths of greater than 25 cm which is suitable for *Thalassia* growth.

There is a warm turbid layer of water along the bottom of Card Sound--a thermal inversion--that exhibited temperatures several degrees above overlying water masses. The thermal inversion layer varied from 6 to 10 inches to 4 to 6 feet deep. Thermographs off the mouth of Model Land Canal recorded temperature maxima of from 91° to 92°F occurring for several days at a time.

Florida Power and Light Company has proposed a discharge of heated effluent to Card Sound after 100% dilution with Biscayne Bay water. A report prepared by the University of Florida, College of Engineering reveals that the introduction of 8500 cfs (5.5 billion gallons per day) of cooling water will significantly elevate water temperature in Card Sound. (8) The cooling water would be discharged to Card Sound with a temperature increase of at least 6°F above intake levels in Biscayne Bay. An area of 1000 acres would exhibit average summer temperatures of about 94°F and the same area would have temperatures in excess of 98°F, five percent of the time. This represents about 7% of the total area of Card Sound. If cooling water from the Turkey Point power facility is discharged to Card Sound, as presently proposed by the Florida Power and Light Company, temperatures in excess of 95°F can be expected in at least 35% of Card Sound five percent of the time. The biological effects which may be induced in both Biscayne Bay and Card Sound by the salinity and circulation changes which implementation of this proposal would cause have not been evaluated.

VIII. DISCUSSION

The Turkey Point Power Plant of the Florida Power and Light Company under present operating conditions discharges 1270 cfs or 820 million gallons per day of cooling water at elevated temperatures to Lower Biscayne Bay. Under normal operating conditions, the temperature increase of the cooling water was never less than 3.3°F during the summer of 1969. An increase of 12°F or greater was observed 16% of the time. Under the most conservative present operating conditions, the increase will exceed 10°F at least 16% of the time (July 1969). This cooling water effluent, discharged through Grand Canal, increased temperatures of the receiving water above 90°F at least 10% of the time, over an area of 620 acres during August 1969. With the construction and operation of the nuclear powered units, the volume of necessary cooling water will be increased nearly four times to 2.75 billion gallons per day and the waste heat will be four times greater than that presently discharged. If this waste heat is discharged to Lower Biscayne Bay, the area of increased temperatures in the bay will be substantially enlarged.

Extensive biological damage to bottom fauna and fish has been observed in the area of increased temperature. The cause of this biological damage to the bay is the waste heat discharge of 1270 cfs from the Florida Power and Light Turkey Point facility. There is no source of artificial organic or chemical pollution which is affecting the water quality of Lower Biscayne Bay. Water quality indicators, other than temperature, demonstrate excellent conditions. Based upon lethal effects only, the biological degradation zone encompassed about 670 acres during the summer of 1969 under the present operating conditions at Turkey Point. This includes no evaluation of the more subtle, long term effects of heat stress upon the biota. When all generating units are in operation, the acute biological damage will occur over a significantly enlarged area for a longer period of time. To prevent further biological damage due to the discharge of cooling water effluent from Florida Power and Light Company's Turkey Point facility, a waste heat control program is urgently required and should be immediately implemented.

The National Technical Advisory Committee in its report to the Secretary of the Interior, April 1, 1968, set strict guidelines for the establishment of temperature criteria. In part, this report states: "All important species, including the most sensitive, must be protected. In the tropics or subtropics, optimum temperatures for many forms are only a few degrees lower than maximum lethal temperatures. Great care should be exercised therefore to prevent harmful increases in maximum summer temperatures in tropical areas." (9)

As a guideline for establishing incremental limits, NTAC recommends the following: "Monthly means of the maximum daily temperatures, recorded at the site in question and before the addition of any heat or artificial origin, should not be raised more than 4°F during the fall, winter and spring (September through May) or by more than 1.5°F during the summer (June through August). The rate of temperature change should not exceed 1°F per hour except when due to natural phenomena. Suggested temperatures are to prevail outside of established mixing zones."

At locations remote from Turkey Point (not closer than 5000 yards from mouth of Grand Canal), the monthly average of daily maximum temperatures in 1968 were: June, 83.1°F; July, 85.6°F; August, 87.2°F. At selected stations in shallow water areas similar to that adjacent to Grand Canal, the monthly average of maximum daily temperature in August was 88.2°F (Table 7). Following the NTAC recommendations of 1.5°F incremental rise, this would produce a maximum allowable temperature of 89.7°F at the mouth of Grand Canal, a temperature which is now exceeded almost continuously from June through August under present operating conditions.

In a report of the Committee on Inshore and Estuarine Pollution (10) (referred to as the Hoover Committee Report), a group of 10 outstanding scientists in the field of marine ecology recommended, in reference to the Turkey Point plant: "The maximum permissible temperature at the outfall must not exceed 90°F."

It is recommended that the waste heat generated by the Florida Power and Light Company Turkey Point facility be abated such that the temperature of the receiving waters is not increased more than 1.5°F from June through August nor more than 4.0°F from September through May above the monthly mean of the maximum daily temperature. The Federal Water Pollution Control Administration, in cooperation with the Florida Department of Air and Water Pollution Control and the Florida Power and Light Company, should establish a temperature monitoring program to determine compliance with the above recommendation.

TABLE 7

MONTHLY AVERAGE OF MAXIMUM DAILY TEMPERATURE* °F

June 1968	Station B-4	84.3
	C-6	82.5
	D-8	82.6
July 1968	Station B-4	85.6
August 1968	Station B-4	88.2
	C-6	86.2
	G-12	88.1

Stations B-4 and G-12 are in shallow water areas similar to that immediately adjacent to Turkey Point and Grand Canal.

*Temperature Studies, Lower Biscayne Bay, Florida, U. S. Department of the Interior, Federal Water Pollution Control Administration, Southeast Water Laboratory, October 1968.

REFERENCES

1. Economically Important Marine Organisms in Biscayne Bay. C. P. Idyll, Division of Fisheries Science, Institute of Marine Science, University of Miami.

2. Economic Study of the Biscayne National Monument. Bureau of Economic and Business Research, College of Business Administration, University of Florida, July 1968.

3. Public Law 90-606, U. S. Congress, 90th Session, H. R. 551, October 1968.

4. Survey, Biscayne Bay. Florida State Board of Health, 1962.

5. Inventory of Municipal Waste Facilities, 1962. Region IV, Division of Water Supply and Pollution Control, U. S. Public Health Service, Atlanta, Georgia.

6. Temperature Studies, Lower Biscayne Bay, Florida. Southeast Water Laboratory, Federal Water Pollution Control Administration, Athens, Georgia, October 1968.

7. Survey of the Biota of Card Sound. E. S. Iversen and M. A. Roessler, Institute of Marine and Atmospheric Sciences, University of Miami, July 1969.

8. Recirculation and Temperature Field Considerations, Turkey Point Facility. Department of Coastal and Oceanographic Engineering, University of Florida, May 1969.

9. Water Quality Criteria. National Technical Advisory Committee, Federal Water Pollution Control Administration, April 1968.

10. Report on the Committee on Inshore and Estuarine Pollution. Hoover Foundation, March 1969.

TEMPERATURE STUDIES
LOWER BISCAYNE BAY, FLORDIA

MARCH 3, 1849

U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST WATER LABORATORY
TECHNICAL PROGRAMS
POLLUTION SURVEILLANCE

October 1968

TEMPERATURE STUDIES

LOWER BISCAYNE BAY, FLORIDA

L. B. TEBO, JR., AQUATIC BIOLOGIST

R. L. ESTES, ELECTRONIC ENGINEER

R. R. LASSITER, BIOMETRICIAN

U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTHEAST WATER LABORATORY
TECHNICAL PROGRAMS
POLLUTION SURVEILLANCE

October 1968

FOREWORD

This report was prepared primarily for limited distribution to parties involved in the thermal problems of Lower Biscayne Bay. It does not present conclusions or suggestions for remedial or corrective action. Rather, it was prepared as a discussion basis among involved officials seeking problem solutions.

It is now being made available to a somewhat larger group of scientists and engineers because of its contribution to the body of data rapidly developing in the field of thermal pollution. It does not purport to be a definitive study; nor is the analysis of the data complete. Biological studies are being conducted by the Florida Power and Light Company and the Institute of Marine Science, University of Miami under Atomic Energy Commission and FWPCA grants. Further analysis of the data is continuing and will be subsequently published in engineering or scientific journals.

The Florida Power and Light Company is currently reviewing current practices for disposal of heated water discharges. Consequently, the patterns of heat influence during this study will probably not be observed permanently.

October 16, 1968

John R. Thoman
Director
Southeast Region
Federal Water Pollution Control Administration
Atlanta, Georgia

TABLE OF CONTENTS

PAGE

FOREWORD -- i

LIST OF FIGURES --- iii

SUMMARY --- 1

INTRODUCTION -- 3

DESCRIPTION OF AREA --- 7

METHODS --- 9

Monitor Studies --------------------------------------- 9
Transect Studies -------------------------------------- 9

RESULTS --- 12

Monitor Studies --------------------------------------- 12
Transect Studies -------------------------------------- 15

APPENDICES

A. Isotherms - July & August Data ------------------ 32
B. Summary of Monitoring Data ---------------------- 55

LIST OF FIGURES

FIGURE PAGE

1 Biscayne Bay Location Map ---------------------- 4

2 Lower Biscayne Bay, Florida, Turkey Point and Vicinity ------------------------------ 6

3 Lower Biscayne Bay Monitoring Station Locations -- 11

4 Lower Biscayne Bay, Turkey Point and Vicinity, July Transect Locations --------------- 17

5 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, August Transect Locations ---- 18

6 Lower Biscayne Bay Maximum Temperatures (°F) ------ 19

7 Lower Biscayne Bay Daily Range of Maximum Temperatures, August 12 - August 26, 1968 -------- 20

8 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 7/28/68 ----------------- 23

9 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 7/29/68, 0922-1104 ------ 24

10 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 7/29/68, 1620-1811 ------ 25

11 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 8/26/68, 1030-1130 ------ 26

12 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 8/26/68, 1500-1600 ------ 27

13 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 8/28/68 ----------------- 28

14 Lower Biscayne Bay, Florida, Turkey Point and Vicinity, Isotherms, 8/25/68 ----------------- 29

15 Lower Biscayne Bay Temperature Profiles - Transect #2, 7/29/68 --------------------------- 30

A1-23 Isotherms - July and August Data ----------------- 32-54

SUMMARY

Florida Power and Light Company is presently operating two fossil fuel power generating units at its Turkey Point Plant adjacent to Lower Biscayne Bay in Dade County, Florida. The Company plans to place two nuclear powered facilities in operation at the same site by 1971 or 1972.

The present units require 1,270 cubic feet per second (cfs) of water for cooling purposes, with a predicted maximum rise in water temperature across the condensers of 13°F. When the nuclear units are in operation there will be a requirement for 4,250 cfs of cooling water, with a predicted maximum rise in temperature across the condensers of 16°F.

To obtain background data on Bay temperature prior to installation of the nuclear facilities and to determine the temperature effect on the Bay of heated effluent from the existing facilities, the Federal Water Pollution Control Administration conducted thermal studies of Lower Biscayne Bay from April through August, 1968.

The studies were made using recording thermometers placed at selected locations throughout the Bay and by intensive short term transect studies in the vicinity of the Turkey Point facility.

Maximum Bay temperatures at those monitoring stations distant from and unaffected by the heated discharge ranged from 82°F in April to 90°F in August. In April, when only one generating unit was in operation, there was no appreciable increase in Bay temperature at those monitoring stations in close proximity to the effluent canals. In August, with both generating units in operation, maximum Bay temperature at these stations ranged from 93°F to 96°F, an increase of 3° to 9°F over background temperature. At those stations influenced by the heated discharge, higher daily fluctuations in temperature occurred -- up to 9°F in 24 hours as compared with 3°F to 4°F at the unaffected monitoring stations.

In late July, during the intensive transect survey, a maximum temperature of 100°F was measured in the Bay adjacent to the effluent canals. During both the July and August intensive transect surveys, the temperature in the vicinity of the effluent canals was 9°F to 11°F over the background temperature of the Bay.

Movement of the heated effluent was invariably in a northeasterly direction around Turkey Point. Maximum movement was on the outgoing tide and water temperatures 4 to 4.5°F over background were found northeast of the tip of Turkey Point (3 1/2 miles from the lower discharge canal) on several occasions. On the basis of the transect studies rate of temperature change resulting from the discharge was as high as 4.5°F per hour at distances up to 850 yards offshore. Maximum rate of change under normal conditions, as shown by the monitors, was never in excess of one degree Fahrenheit per hour.

Discharge from the applicant canals was occasionally more saline than bay water with the result that temperature inversions occurred (warmer water near bottom).

TEMPERATURE STUDIES - LOWER BISCAYNE BAY

INTRODUCTION

In April 1967 Florida Power and Light Company placed one conventional fossil fueled power generating unit in operation at Turkey Point adjacent to Lower Biscayne Bay in Dade County, Florida (Figure 1). In May 1968 an additional fossil fueled unit was placed in operation and the Florida Power and Light Company is constructing two nuclear powered units to be placed in operation at the same site by 1971-1972.

The two fossil units have a combined maximum capability of generating 864,000 kilowatts (KWe) requiring a flow of 1270 cubic feet per second (cfs) of water for cooling purposes (Table 1). The nuclear units have a maximum capability of 1,520,000 KWe utilizing 2980 cfs of cooling water. The four combined units will have a total capability of generating 2,384,000 KWe with a cooling water flow of 4250 cfs.

As shown in Table 1, the above figures on power generation are maximum overload capability and the normal full load from all four units will approximate 2,080,000 KWe or 87 per cent of the maximum.

The July 1968 loads on the two units presently in operation ranged from 293,000 KWe to 742,000 KWe and the monthly average (based on 4 hour intervals) was 571,000 KWe. Peak loading occurred in the afternoon and early evening hours.

Water for cooling purposes is drawn from Lower Biscayne Bay at an intake location just north of and immediately adjacent to Turkey Point. The cooling water is then discharged back into the Bay south of Turkey Point via a series of canals located on Florida Power and Light property adjacent to the plant site (Figure 2).

The amount of water flowing across the condensers remains the same,

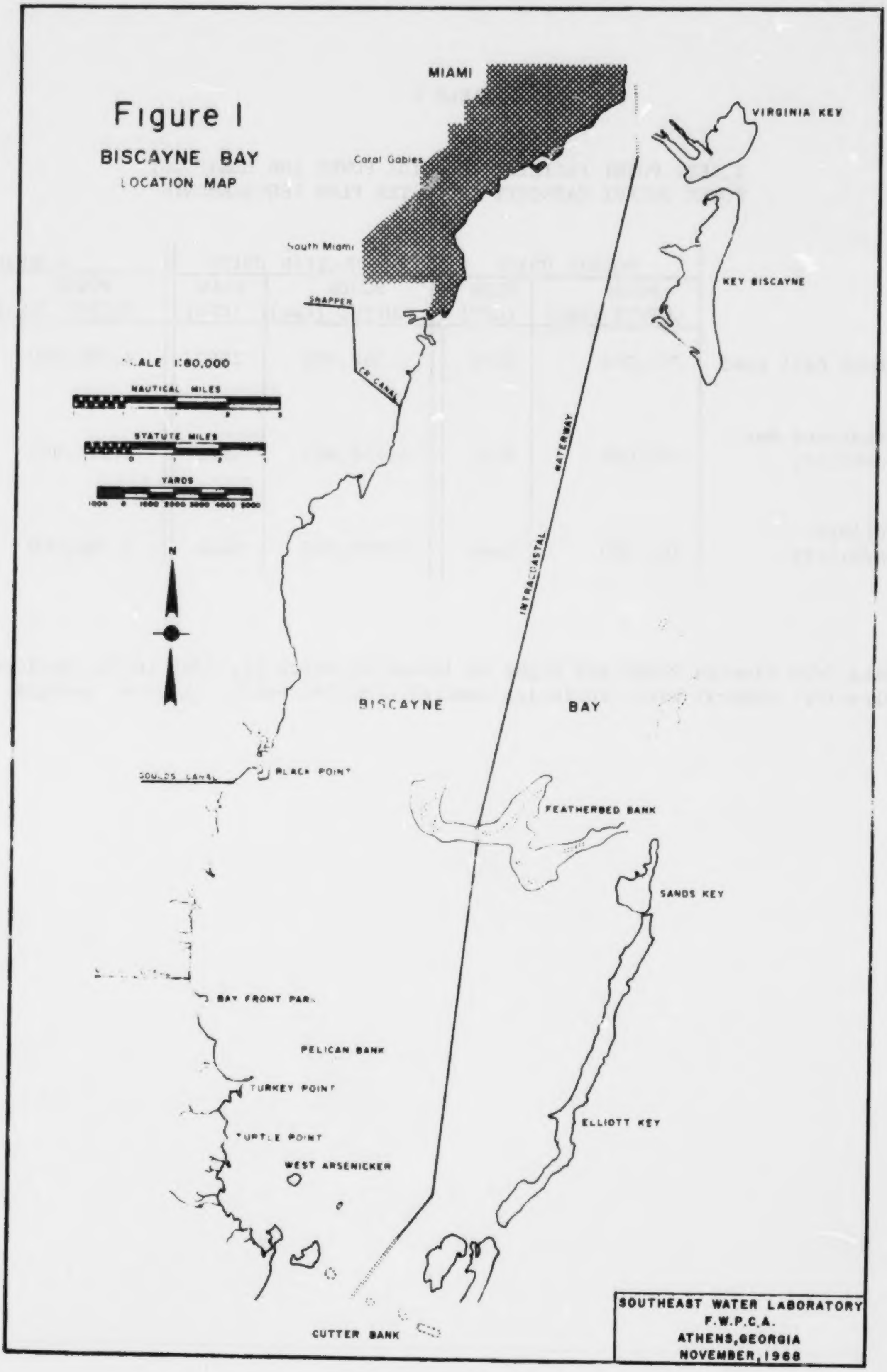


Figure I

BISCAYNE BAY
LOCATION MAP

MIAMI
Coral Gables
South Miami
SNAPPER CR CANAL
VIRGINIA KEY
KEY BISCAYNE
SCALE 1:80,000
NAUTICAL MILES
STATUTE MILES
YARDS
1000 0 1000 2000 3000 4000 5000
N
INTRACOASTAL WATERWAY
BISCAYNE BAY
GOULDS CANAL
BLACK POINT
FEATHERBED BANK
SANDS KEY
BAY FRONT PARK
PELICAN BANK
TURKEY POINT
TURTLE POINT
WEST ARSENICKER
ELLIOTT KEY
CUTTER BANK

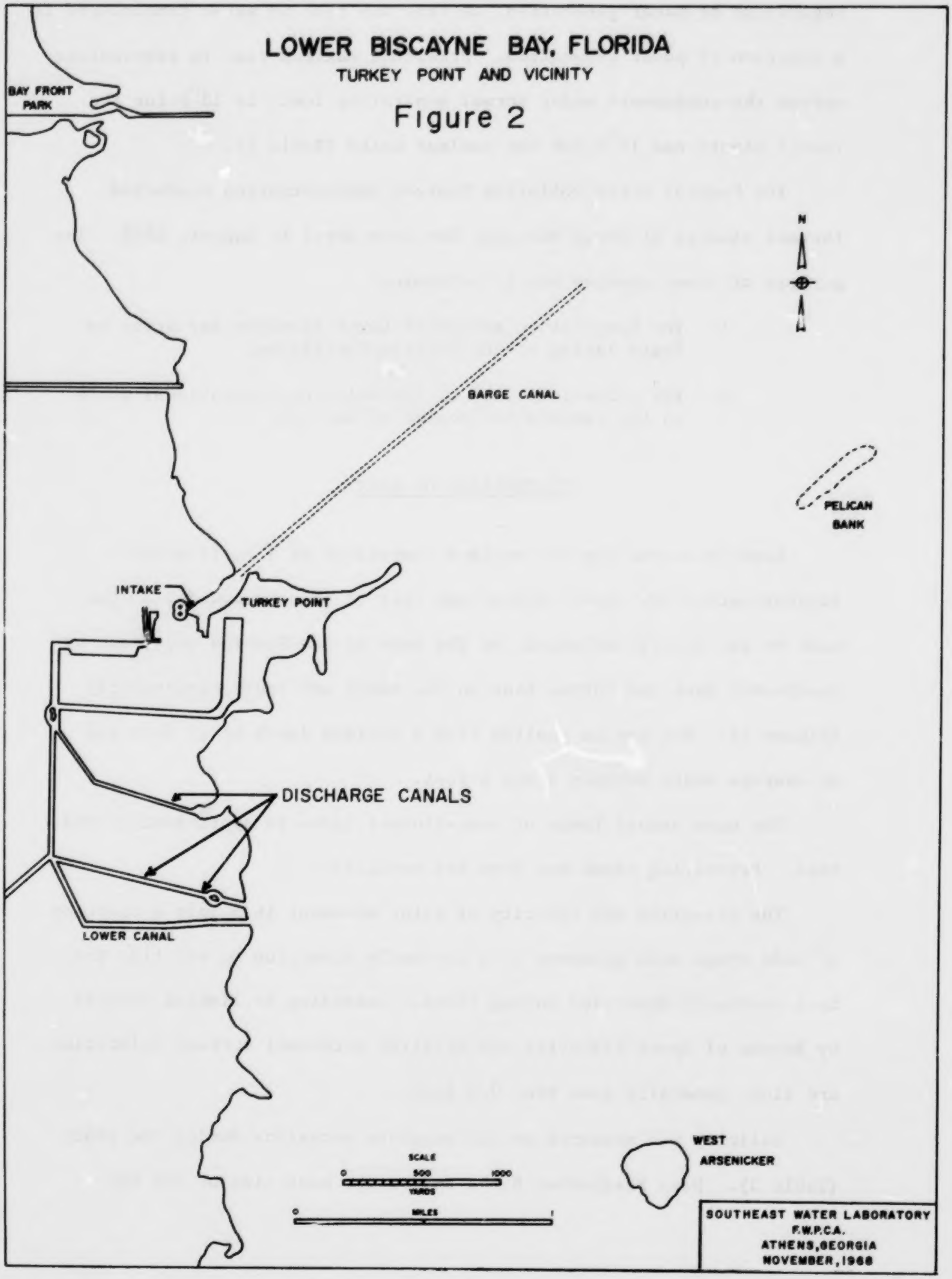
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

TABLE 1

TURKEY POINT FACILITY, FLORIDA POWER AND LIGHT CO. POWER OUTPUT CAPACITY AND WATER FLOW REQUIREMENTS[1]

	FOSSIL UNITS		NUCLEAR UNITS		COMBINED	
	POWER OUTPUT (KWe)	FLOW (CFS)	POWER OUTPUT (KWe)	FLOW (CFS)	POWER OUTPUT (KWe)	FLOW (CFS)
Normal Full Load	720,000	1270	1,360,000	2980	2,080,000	4250
Guaranteed Max. Capability	740,000	Same	1,456,000	Same	2,196,000	Same
Overload Capability	864,000	Same	1,520,000	Same	2,384,000	Same

[1] Data from Florida Power and Light by letter of March 11, 1968 to the Regional Director, Federal Water Pollution Control Administration, Atlanta, Georgia.


BAY FRONT PARK
N
BARGE CANAL
PELICAN BANK
INTAKE
TURKEY POINT
DISCHARGE CANALS
LOWER CANAL
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
Figure 2

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

regardless of power generation, so that the rise in water temperature is a function of power generation. Predicted maximum rise in temperature across the condensers under normal generating loads is 13°F for the fossil plants and 16°F for the nuclear units (Table 2).

The Federal Water Pollution Control Administration conducted thermal studies of Lower Biscayne Bay from April to August, 1968. The purpose of these studies was to determine:

1. The temperature regime of Lower Biscayne Bay prior to installation of the nuclear facilities;
2. The effect, if any, of the existing conventional units on the temperature regime of the Bay.

DESCRIPTION OF AREA

Lower Biscayne Bay has maximum dimensions of 9 by 11 miles (approximately 100 square miles) and lies in an area bounded on the west by the Florida mainland, on the east by the Florida keys, and by Featherbed Bank and Cutter Bank on the north and south, respectively (Figure 1). The Bay is shallow with a maximum depth of 13 feet and an average depth between 5 and 6 feet.

The mean annual range of semi-diurnal tides is approximately two feet. Prevailing winds are from the southeast.

The direction and velocity of water movement is mainly a function of tide stage with movement in a northerly direction on ebb tide and in a southerly direction during flood. According to limited studies by Bureau of Sport Fisheries and Wildlife personnel current velocities are slow, generally less than 0.3 knots.

Salinity was measured on two separate occasions during the study (Table 3). Near Featherbed Banks and on the east side of the Bay

TABLE 2

TURKEY POINT FACILITY, FLORIDA POWER AND LIGHT CO. PREDICTED RISE OF TEMPERATURE ABOVE INTAKE TEMPERATURES AT VARIOUS LEVELS OF POWER GENERATION[1]

	POWER OUTPUT (KWe)	PREDICTED TEMPERATURE RISE(°F)
Fossil Units	100,000	4
	200,000	7
	300,000	10
	400,000	13
Nuclear Units	200,000	6
	400,000	10
	600,000	14
	728,000	16

---

[1] Data from Florida Power and Light Co. by letter of March 11, 1968 to the Regional Director, Federal Water Pollution Control Administration, Atlanta, Georgia.

near the barrier islands the salinity ranged from near to slightly in excess of sea strength (34.9-38.5 parts per thousand, $^{o}/oo$). On the west, or landward side of the Bay, in the vicinity of Turkey Point salinity was much lower, ranging from 23.8 to 33.2 $^{o}/oo$.

METHODS

Monitor Studies

Continuous temperature recording instruments were used to obtain a record of water temperature at selected locations in the Bay. The instrument used consisted of a spring wound, clock driven, 15 day chart with a bimetallic sensing element enclosed in a waterproof stainless steel case. The thermographs used had a range of 60 - 120°F. and in a water bath had a measured full scale response time of two hours for a 60°F step increase in temperature.

The thermographs were suspended approximately 14 inches under the water surface below a 12" x 12" x 17" block of styrofoam which was anchored by means of stainless steel cable to a 5/8" steel rod driven into the bottom of the Bay.

Eighteen station locations were originally selected by dividing the bay into six quadrants and systematically, with a random start, placing three monitors in each quadrant. However, because of apparent theft in the early phases of the study, the above design was abandoned. Sufficient data for analysis were obtained only from the ten stations shown on Figure 3. Station H13A had two monitors; one at a depth of 14 inches and one approximately one foot from the bottom.

Transect Studies

In late July and August intensive studies of water temperature in the area around Turkey Point were conducted. Transects extending

near the barrier islands the salinity ranged from near to slightly in excess of sea strength (34.9-38.5 parts per thousand, $^{o}/oo$). On the west, or landward side of the Bay, in the vicinity of Turkey Point salinity was much lower, ranging from 23.8 to 33.2 $^{o}/oo$.

METHODS

Monitor Studies

Continuous temperature recording instruments were used to obtain a record of water temperature at selected locations in the Bay. The instrument used consisted of a spring wound, clock driven, 15 day chart with a bimetallic sensing element enclosed in a waterproof stainless steel case. The thermographs used had a range of 60 - 120°F and in a water bath had a measured full scale response time of two hours for a 60°F step increase in temperature.

The thermographs were suspended approximately 14 inches under the water surface below a 12" x 12" x 17" block of styrofoam which was anchored by means of stainless steel cable to a 5/8" steel rod driven into the bottom of the Bay.

Eighteen station locations were originally selected by dividing the bay into six quadrants and systematically, with a random start, placing three monitors in each quadrant. However, because of apparent theft in the early phases of the study, the above design was abandoned. Sufficient data for analysis were obtained only from the ten stations shown on Figure 3. Station H13A had two monitors; one at a depth of 14 inches and one approximately one foot from the bottom.

Transect Studies

In late July and August intensive studies of water temperature in the area around Turkey Point were conducted. Transects extending

near the barrier islands the salinity ranged from near to slightly in excess of sea strength (34.9-38.5 parts per thousand, $^{o}/oo$). On the west, or landward side of the Bay, in the vicinity of Turkey Point salinity was much lower, ranging from 23.8 to 33.2 $^{o}/oo$.

METHODS

Monitor Studies

Continuous temperature recording instruments were used to obtain a record of water temperature at selected locations in the Bay. The instrument used consisted of a spring wound, clock driven, 15 day chart with a bimetallic sensing element enclosed in a waterproof stainless steel case. The thermographs used had a range of 60 - 120°F and in a water bath had a measured full scale response time of two hours for a 60°F step increase in temperature.

The thermographs were suspended approximately 14 inches under the water surface below a 12" x 12" x 17" block of styrofoam which was anchored by means of stainless steel cable to a 5/8" steel rod driven into the bottom of the Bay.

Eighteen station locations were originally selected by dividing the bay into six quadrants and systematically, with a random start, placing three monitors in each quadrant. However, because of apparent theft in the early phases of the study, the above design was abandoned. Sufficient data for analysis were obtained only from the ten stations shown on Figure 3. Station H13A had two monitors; one at a depth of 14 inches and one approximately one foot from the bottom.

Transect Studies

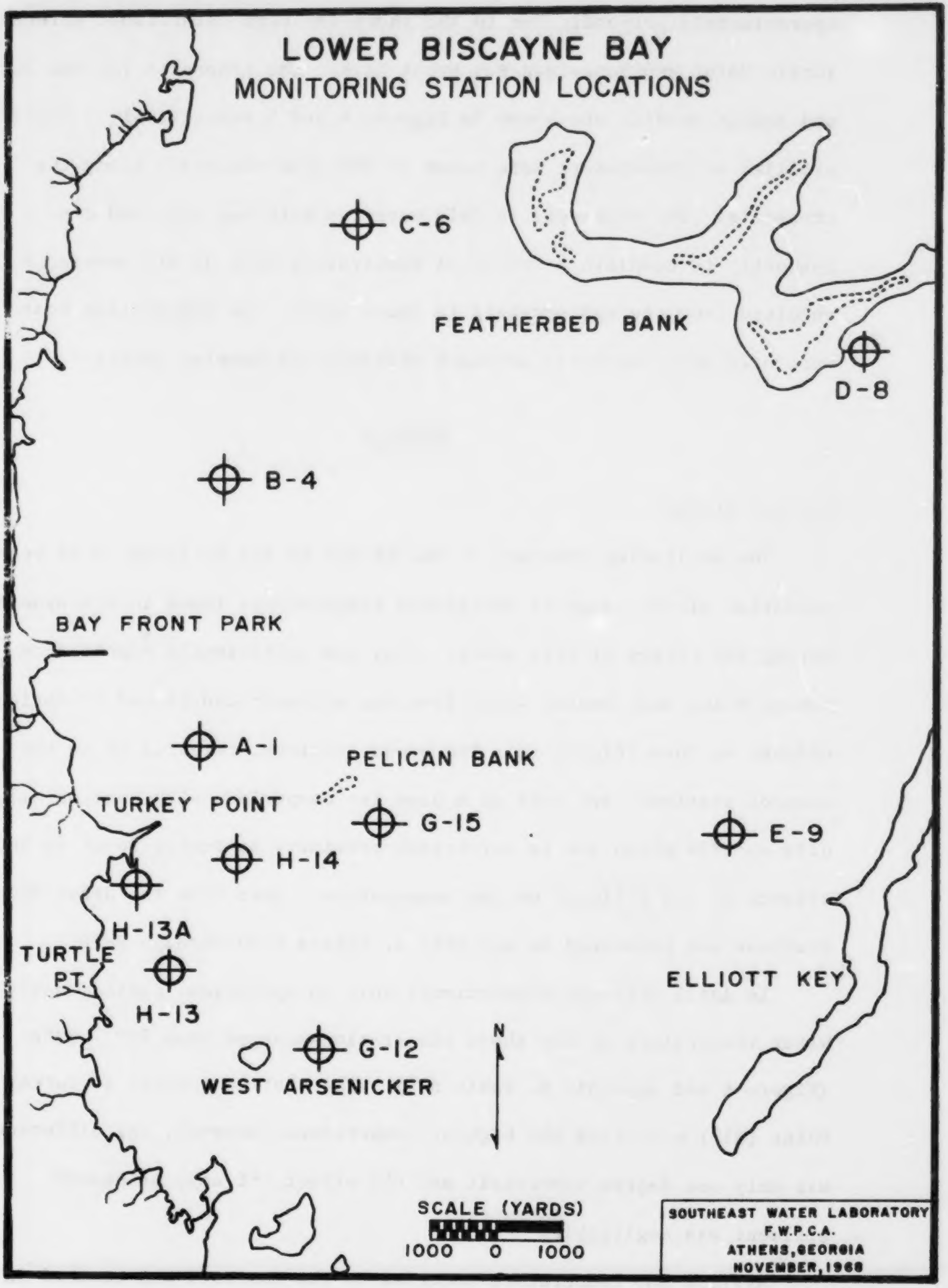
In late July and August intensive studies of water temperature in the area around Turkey Point were conducted. Transects extending

TABLE 3

SALINITY (PARTS PER THOUSAND, °/oo) AT VARIOUS LOCATIONS
LOWER BISCAYNE BAY DURING JULY AND AUGUST, 1968

LOCATION	7/27	8/24
Off Turtle Point (Transects 2 & 3)	27.5	31.1
Turkey Point (Transects 4 & 8)	28.6	33.2
First Canal Above Turkey Point (Transects 5 & 10)	23.8	29.8
Bayfront Park (Transect 12)		29.2
Featherbed Bank (Station D7, D8)	38.5	
Elliot Key Park (Station E9)	34.9	
West Arsenicker (Station G12)	37.0	

Figure 3


LOWER BISCAYNE BAY
MONITORING STATION LOCATIONS
C-6
FEATHERBED BANK
D-8
B-4
BAY FRONT PARK
A-1
PELICAN BANK
TURKEY POINT
G-15
E-9
H-14
H-13A
TURTLE PT.
H-13
ELLIOTT KEY
N
G-12
WEST ARSENICKER
SCALE (YARDS)
1000 0 1000
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

approximately perpendicular to the shoreline were established between Turtle Point and Homestead Bay Front Park. The transects for the July and August studies are shown in Figures 4 and 5, respectively. Vertical profiles of temperature were taken at 100 yard intervals along the transects. The transects in July were run with one boat and consequently to complete a series of temperature data at all transects required from one and one-half to three hours. In August five boats were used simultaneously and each transect was sampled hourly.

RESULTS

Monitor Studies

The monitoring stations at B4, C6 and E9 are believed to be representative of the range of background temperatures found in Biscayne Bay during the period of this study. They are sufficiently remote from Turkey Point that heated water from the effluent canals had no obvious effects on them (Figure 3). The above stations, referred to as the control stations, are used as a base for comparison with Station H13, H13A and H14 which are in sufficient proximity to Turkey Point to show effects of the effluent on bay temperature. Data from the other four stations are presented in Appendix B, Tables B-20 through B-28.

In April with one conventional unit in operation, maximum daily water temperature at the above six stations ranged from 81° - 83°F (Figure 6 and Appendix B, Table B-1). The station closest to Turkey Point (H13) exhibited the highest temperature; however, the differential was only one degree Fahrenheit and the effect, if any, of heated effluent was negligible.

Maximum Bay temperature recorded by the monitors was reached in mid-August, 1968 (Figure 6 and Appendix B, Table B-1. At stations H13, H13A, and H14 the maximum temperatures ranged from 93° - 96°F, an increase of 3° to 9°F over the control stations (Figure 6).

The mean daily maximum temperatures for the period August 12 to August 23 at the control and affected stations were compared by analysis of variance (Table 4). The temperature differences between control and affected stations were found to be highly significant. Statistically this means that we can state, with a high probability of being correct (greater than 99%), that the differences in maximum temperatures during August (as shown in Figure 6) are true differences.

Two of the stations nearest Turkey Point (H13A and H14) had much higher daily fluctuations in temperature as compared with the control stations (Figure 7 and Appendix B, Table B-2). During the two week period when maximum temperatures were reached (August 13 - August 26) the maximum daily range in temperature (i.e., the difference between the daily maximum and minimum temperature) at the control stations was 5°F at station B4. Stations C6 and E9 had maximum daily fluctuations of 4°F and 3°F, respectively. Stations H13A and H14 had maximum daily fluctuations of 9°F and 7°F, respectively.

The transect data show that movement of heated water from the mouth of the lower canal is invariably north to northeast around Turkey Point. Station H13 lies in a southeasterly direction from the mouth of the canal, out of the path of the heated discharge, and does not exhibit the high daily fluctuation in temperature observed at stations H13A and H14.

Maximum hourly rate of temperature change was found at monitor stations H13A and H13 and amounted to 3.0°F/hour (Appendix B, Tables B-3 through B-19).

TABLE 4

ANALYSIS OF VARIANCE WITH SELECTED COMPARISON OF WATER TEMPERATURE AT STATIONS IN LOWER BISCAYNE BAY FOR THE PERIOD AUGUST 12 - AUGUST 23, 1968

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F
Total	71	489.78		
Treatments	5	366.44	73.29	39.19**
B4, E9 & C6 vs H13, H13A & H14	1	245.68	245.68	131.38**
H13A vs H13 & H14	1	72.00	72.00	38.50**
B4 vs C6 & E9	1	51.68	51.68	27.64**
Error	66	123.33	1.87	

**Significant at 1% level.

Transect Studies

Results of the transect studies conducted in July and August are shown in text Figures 8 through 14 and Appendix A - Figures A1 through A23.

Maximum temperatures of 100^{o}F were found near the mouth of the lower canal on July 28 and 29 (Figures 8 and 10). Water temperature at the mouth of the lower canal varied from 6^{o} to 11^{o}F higher than background temperature of the Bay and was generally from 9^{o} - 11^{o}F higher than background (Figures 8 through 14).

Movement of the heated effluent was invariably in a northeasterly direction around Turkey Point on the outgoing tide. Water temperatures 4^{o} to 4.5^{o}F over background temperature were found northeast of the tip of Turkey Point on several occasions.

The transects in August were run on an hourly basis and indicated a maximum rate of temperature change of as high as 4.5^{o}F/hour at distances 850 yards offshore (Tables 5 and 6).

Vertically the water was generally well mixed with slight differences (usually 1^{o} - 2^{o}F) between surface and bottom temperatures. On several occasions the transect studies showed a temperature inversion, that is, the warmer water was near the bottom (Figure 15). A check of salinity in the top and bottom layers revealed that the water near the bottom had a higher salinity and was therefore more dense than the cooler surface water. There are insufficient data to evaluate the cause of this occasional increase in salinity. A reasonable hypothesis is that the increase of temperature across the condensers results in a high rate of evaporation in the canals with a subsequent increase in salinity of the effluent when it reaches the Bay.

During the study, a gross evaluation of the cooling effects of the discharge canals was made. Temperature was measured at several points in the canal (Figures 13 and 14) and compared to the temperature of the water being discharged to the Bay at the mouth of the lower canal. The maximum decrease in temperature ranged from 1.5°F to 3.5°F.

Figure 4

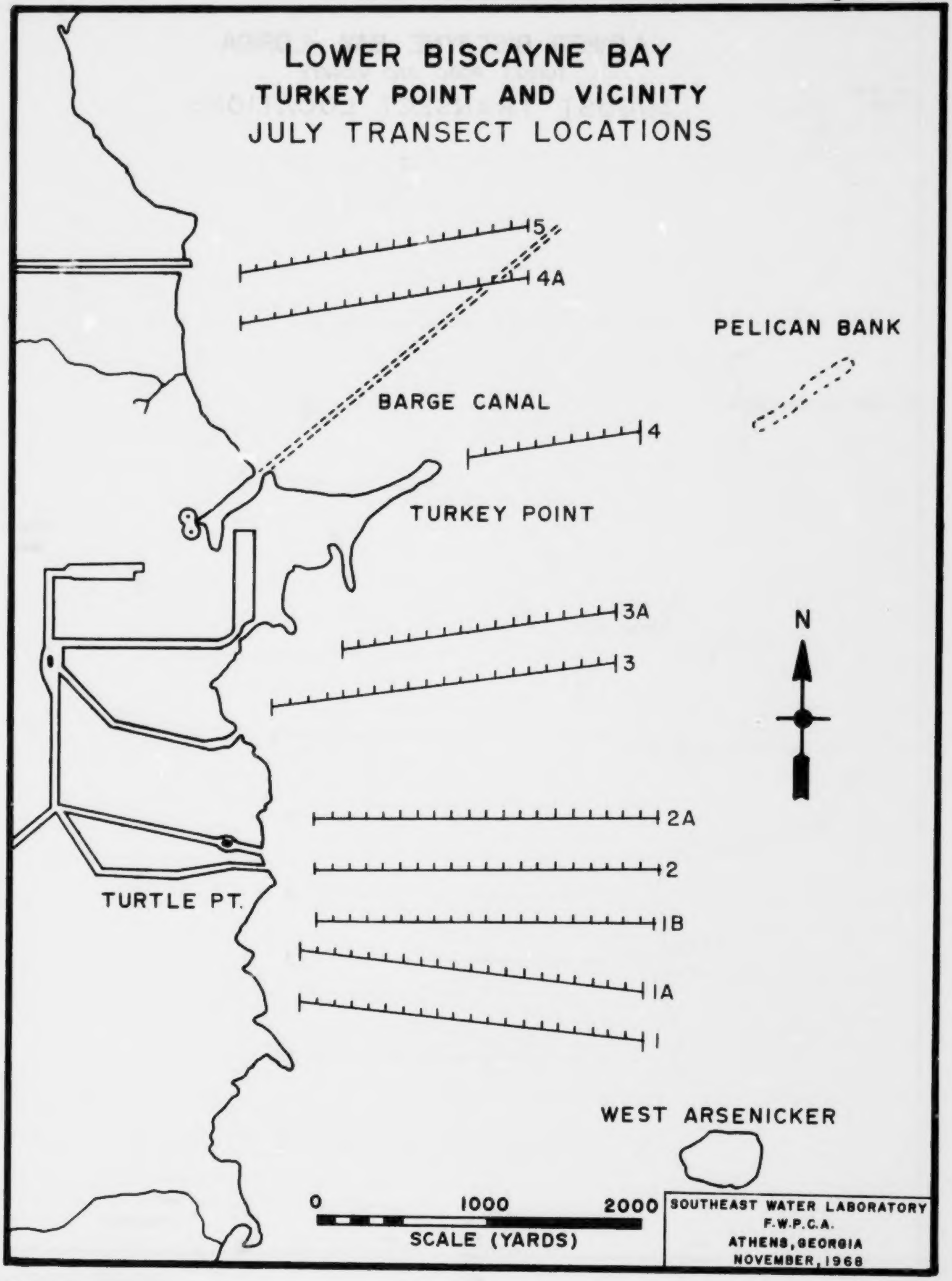

LOWER BISCAYNE BAY
TURKEY POINT AND VICINITY
JULY TRANSECT LOCATIONS
5
4A
PELICAN BANK
BARGE CANAL
4
TURKEY POINT
3A
3
N
2A
2
TURTLE PT.
1B
1A
1
WEST ARSENICKER
0
1000
2000
SCALE (YARDS)
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 5

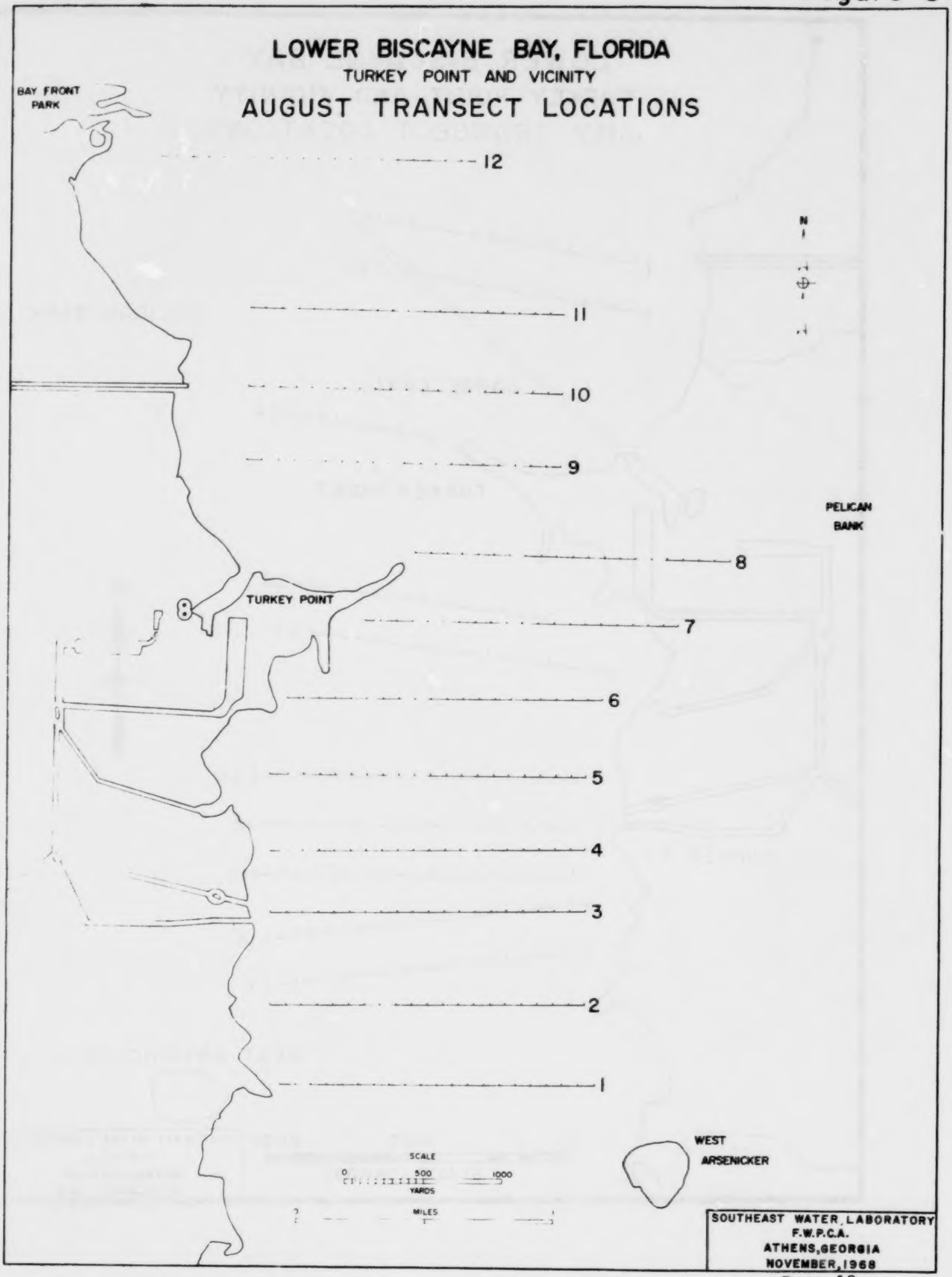

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
AUGUST TRANSECT LOCATIONS
BAY FRONT PARK
12
N
11
10
9
PELICAN BANK
8
TURKEY POINT
7
6
5
4
3
2
1
WEST ARSENICKER
SCALE
0
500
1000
YARDS
MILES
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 6

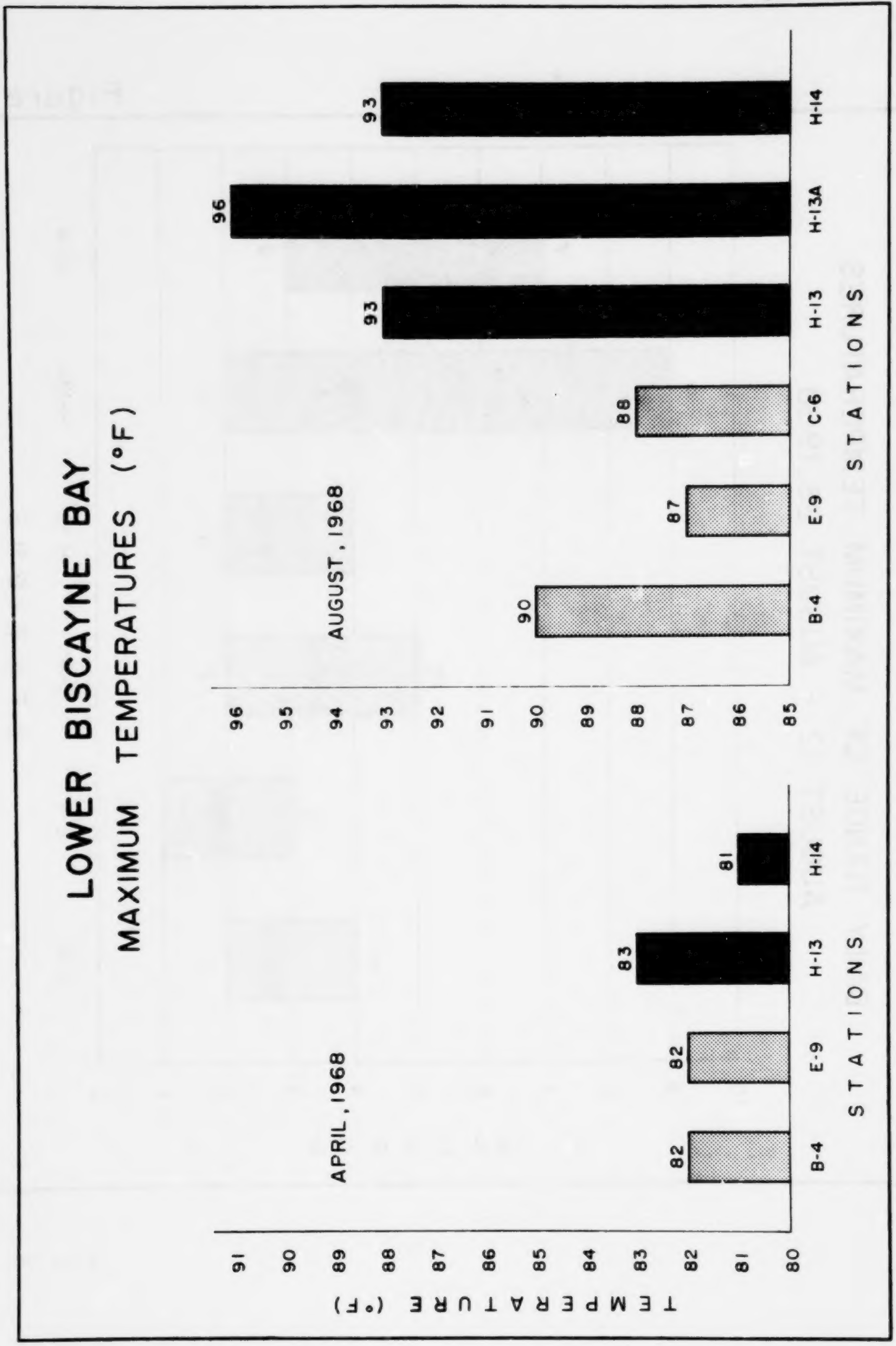
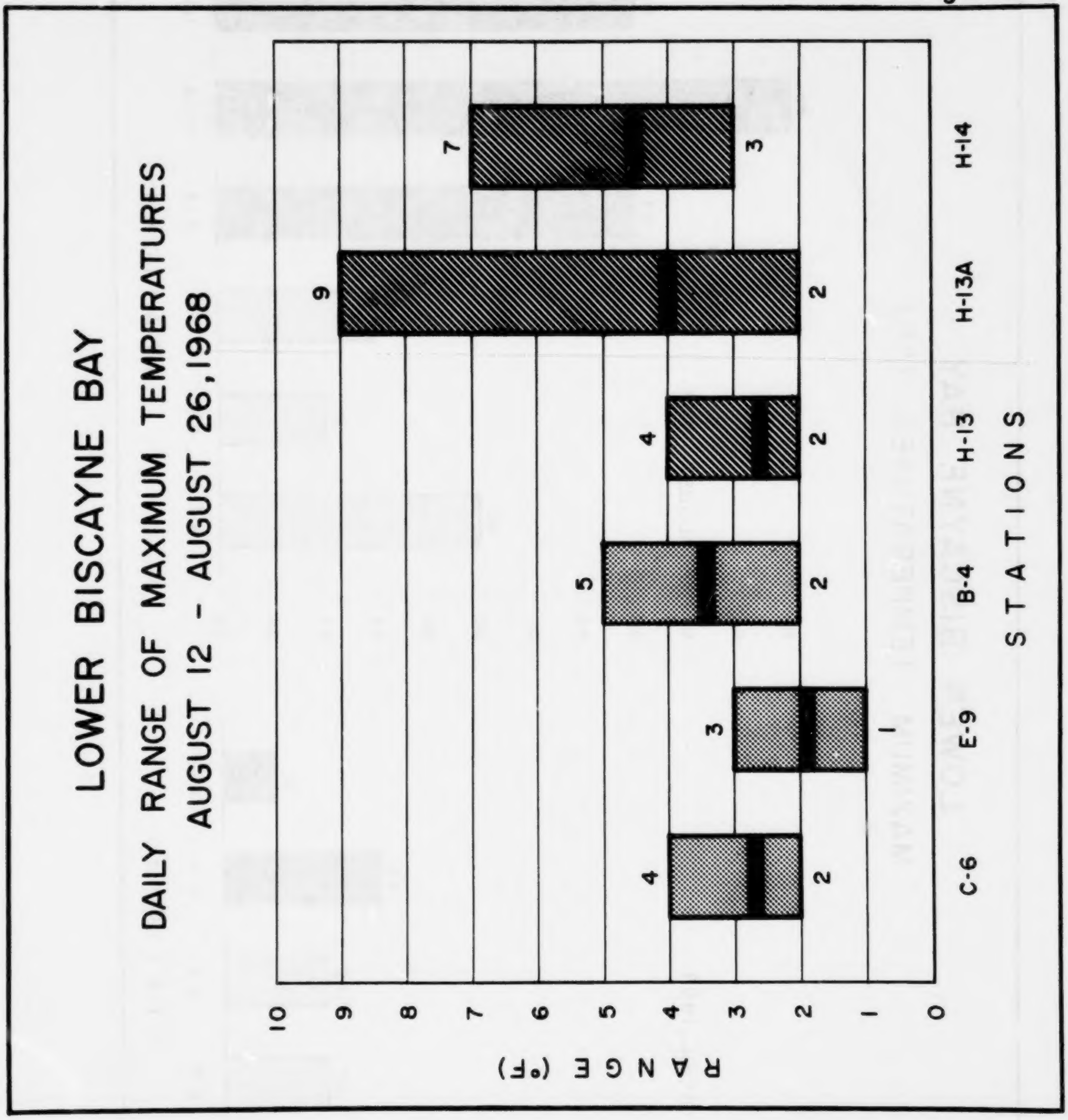

LOWER BISCAYNE BAY
MAXIMUM TEMPERATURES (°F)
TEMPERATURE (°F)
APRIL, 1968
91
90
89
88
87
86
85
84
83
82
81
80
82
82
83
81
B-4
E-9
H-13
H-14
STATIONS
AUGUST, 1968
96
95
94
93
92
91
90
89
88
87
86
85
90
87
88
93
96
93
B-4
E-9
C-6
H-13
H-13A
H-14
STATIONS

Figure 7



LOWER BISCAYNE BAY

DAILY RANGE OF MAXIMUM TEMPERATURES

AUGUST 12 - AUGUST 26, 1968

TIME INTERVAL	POINT #1 °F	POINT #2 °F	POINT #3 °F	POINT #4 °F	POINT #5 °F	POINT #6 °F	POINT #7 °F	POINT #8 °F
0930-1030	2.7	0.9	0.9	0	0	1.8	0	2.7
1030-1130	0.9	0	0	0.9	3.6	0.9	1.8	1.8
1300-1400	0.7	0	0.4	0.4	1.1	0.7	0.7	1.1
1400-1500	1.8	0	0	0.9	1.8	3.6	4.5	4.5
1500-1600	1.8	1.8	0	0.9	0	0.9	0.9	1.8
1600-1700	1.8	0	0.9	0.9	0.9	1.8	0.9	0

TABLE 5

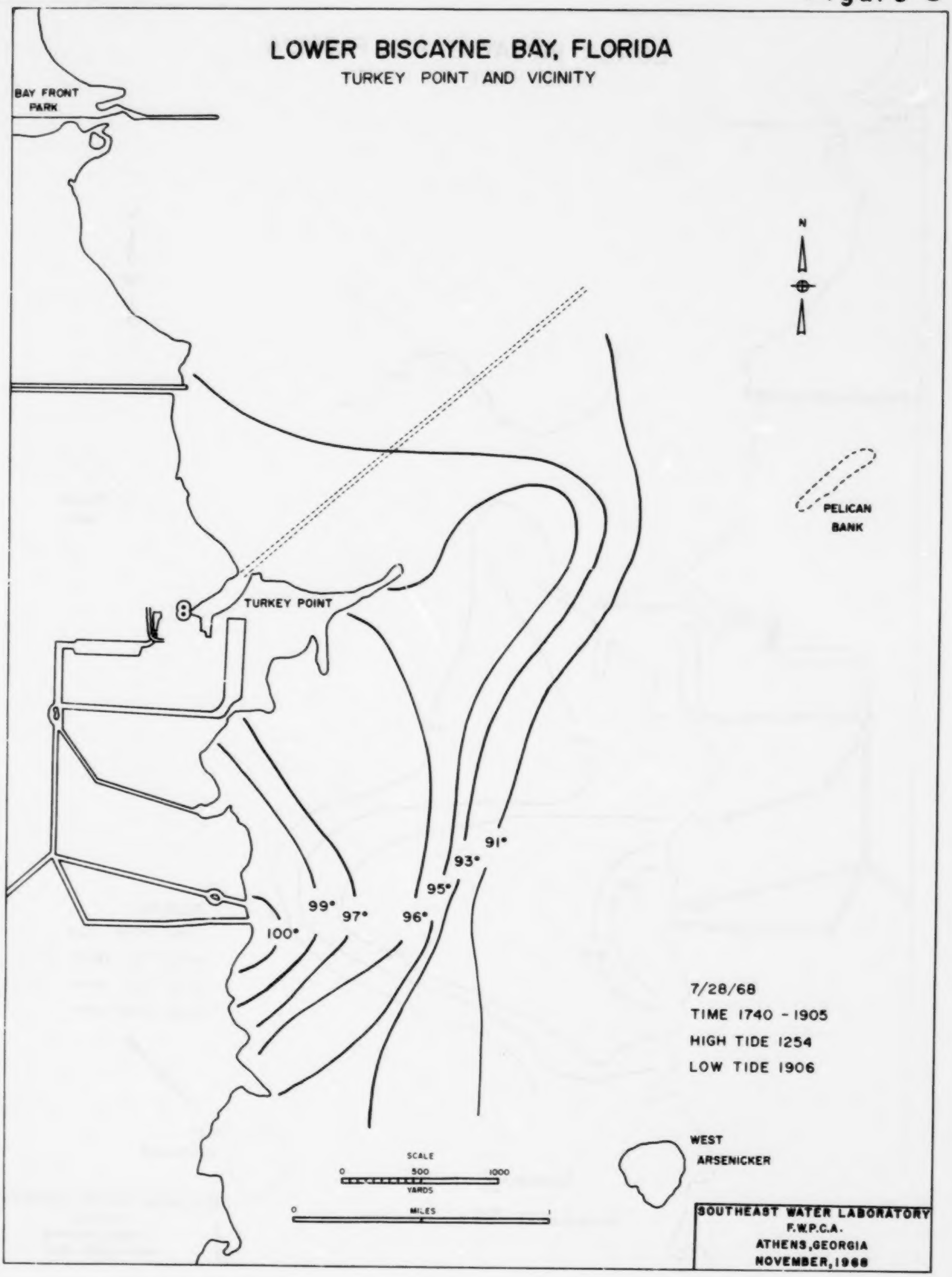
TEMPERATURE CHANGE (°F PER HOUR) AT SUCCESSIVE POINTS 100 YARDS APART ALONG TRANSECT NUMBER 3 ON AUGUST 26, 1968
(POINT #1 APPROXIMATELY 150 YARDS OFFSHORE)

TIME INTERVAL	POINT #1 °F	POINT #2 °F	POINT #3 °F	POINT #4 °F	POINT #5 °F	POINT #6 °F	POINT #7 °F	POINT #8 °F
0930-1030	0.9	0.9	0.9	0	0	2.7	2.7	0.9
1030-1130	0.9	0	0	0.9	3.6	0.9	1.9	1.8
1300-1400	0.7	0	0.2	0.4	1.1	0.7	0.7	0.7
1400-1500	1.8	0	0	0.9	1.8	3.6	4.5	4.5
1500-1600	1.8	1.8	1.8	0.9	0	0.9	0.9	1.8
1600-1700	1.8	0	0.9	0.9	0.9	1.8	0.9	1.8

TABLE 6

TEMPERATURE CHANGE (°F PER HOUR) AT SUCCESSIVE POINTS 100 YARDS APART ALONG TRANSECT NUMBER 3 ON AUGUST 26, 1968
(POINT #1 APPROXIMATELY 150 YARDS OFFSHORE)

Figure 8



LOWER BISCAYNE BAY, FLORIDA

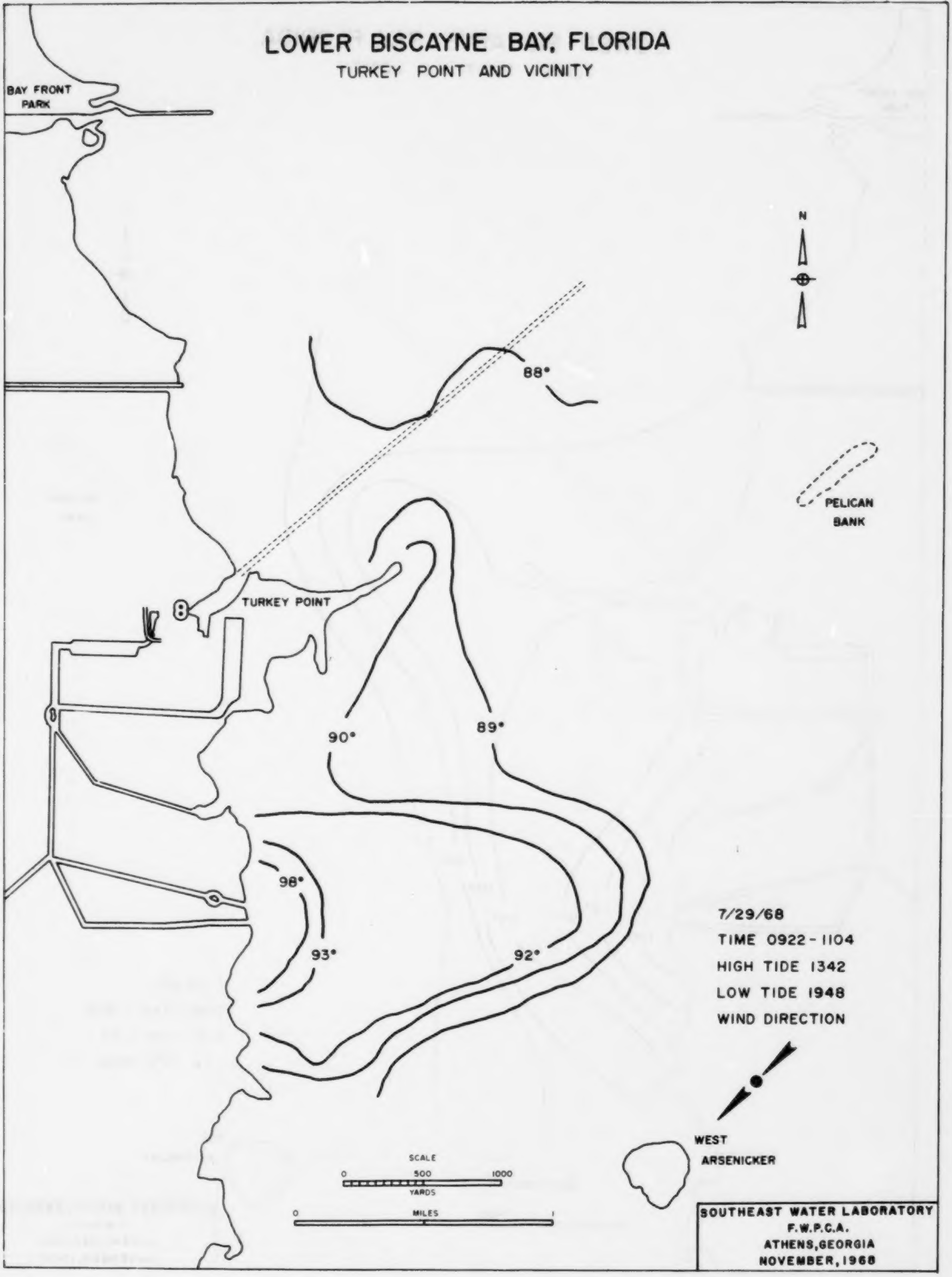
TURKEY POINT AND VICINITY

BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
91°
93°
95°
96°
97°
99°
100°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

7/28/68
TIME 1740 - 1905
HIGH TIDE 1254
LOW TIDE 1906

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 9



LOWER BISCAYNE BAY, FLORIDA

TURKEY POINT AND VICINITY

7/29/68
TIME 0922-1104
HIGH TIDE 1342
LOW TIDE 1948
WIND DIRECTION

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

BAY FRONT PARK
N
88°
PELICAN BANK
TURKEY POINT
90°
89°
98°
93°
92°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

Figure 10

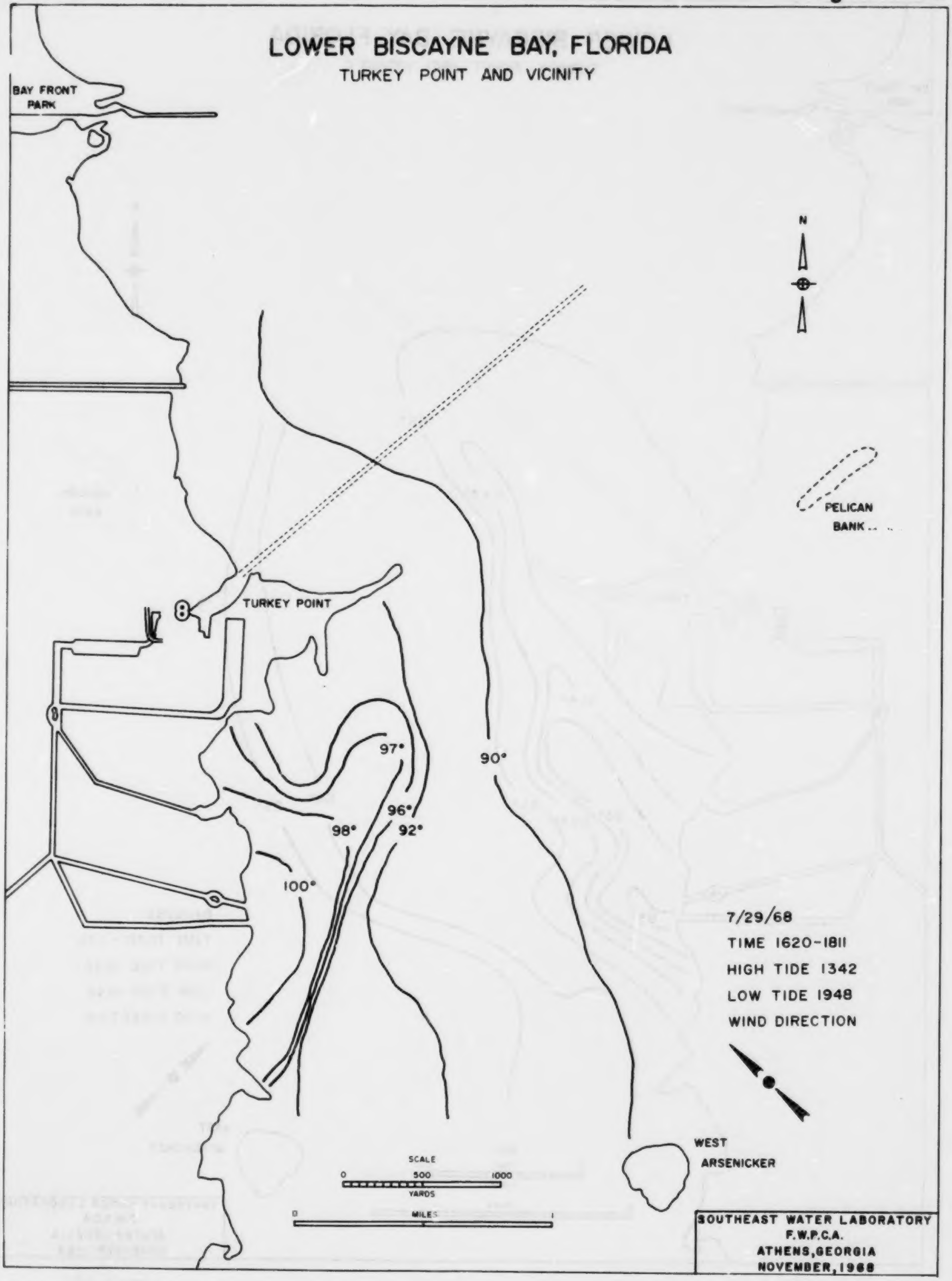

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
97°
90°
96°
98°
92°
100°
7/29/68
TIME 1620-1811
HIGH TIDE 1342
LOW TIDE 1948
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure II

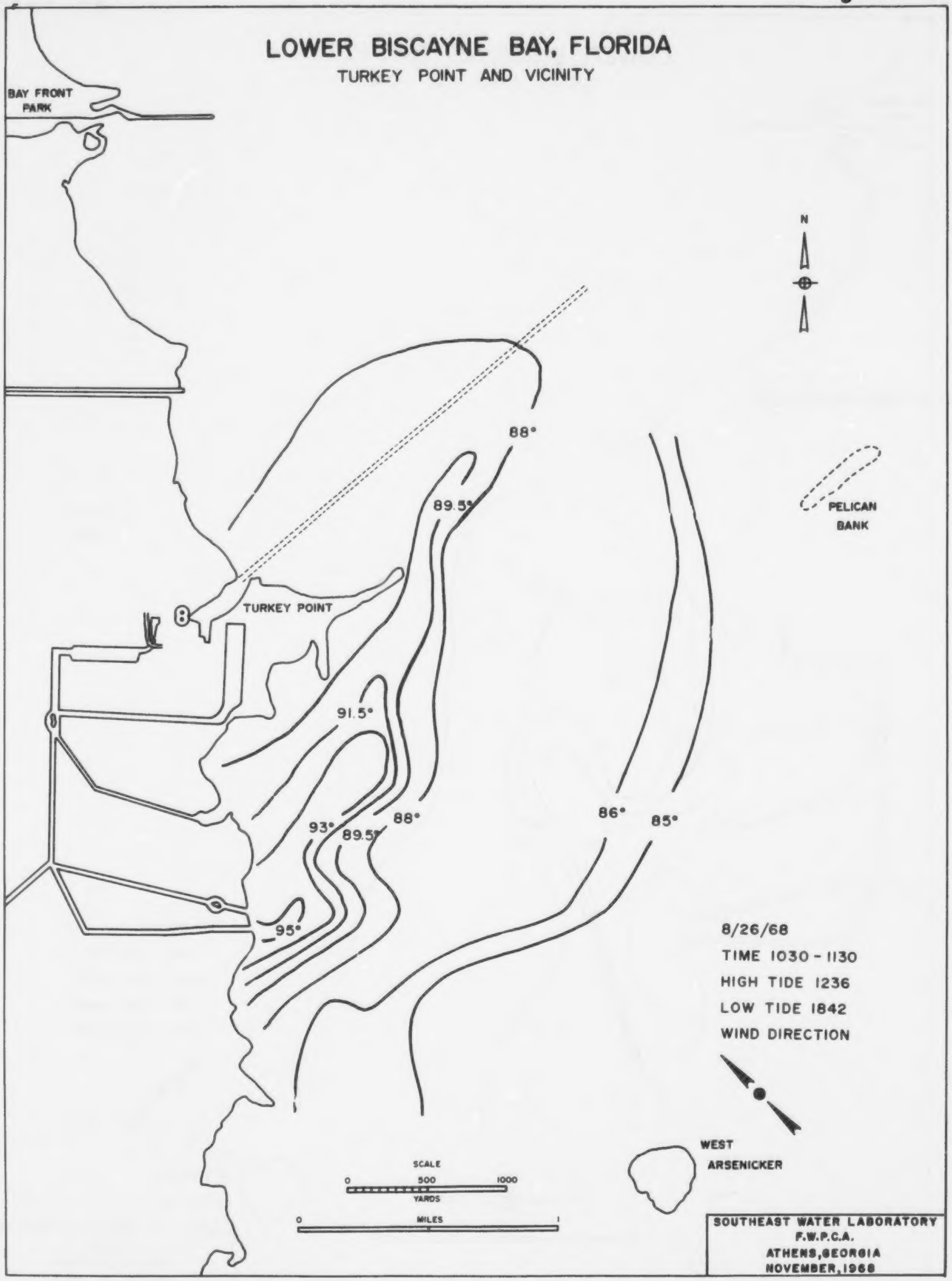
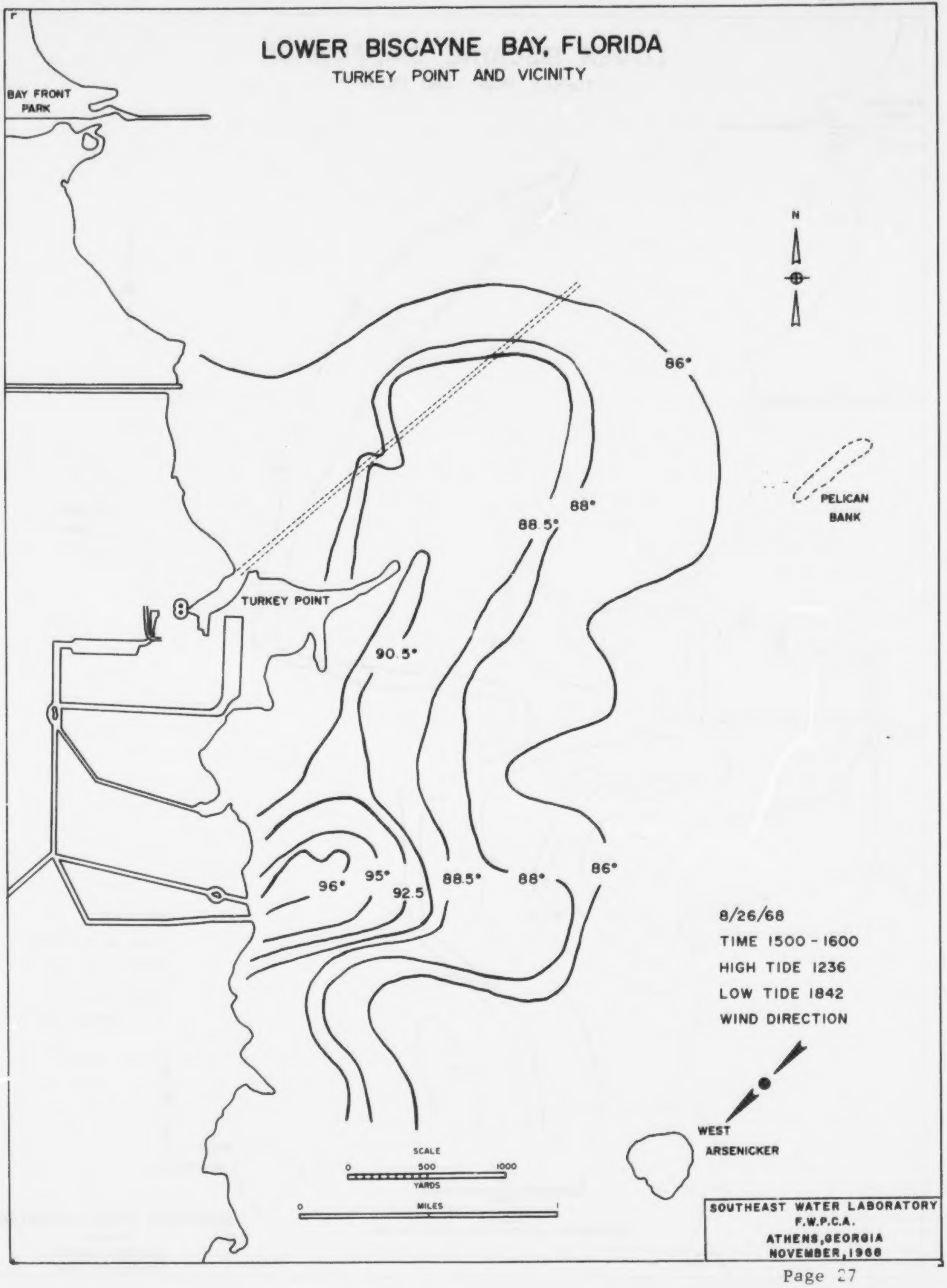

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
89.5°
PELICAN BANK
TURKEY POINT
91.5°
93°
89.5°
88°
86°
85°
95°
8/26/68
TIME 1030 - 1130
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 12



LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY

BAY FRONT PARK
N
86°
88°
88.5°
PELICAN BANK
TURKEY POINT
90.5°
96°
95°
92.5
88.5°
88°
86°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

8/26/68
TIME 1500 - 1600
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 13

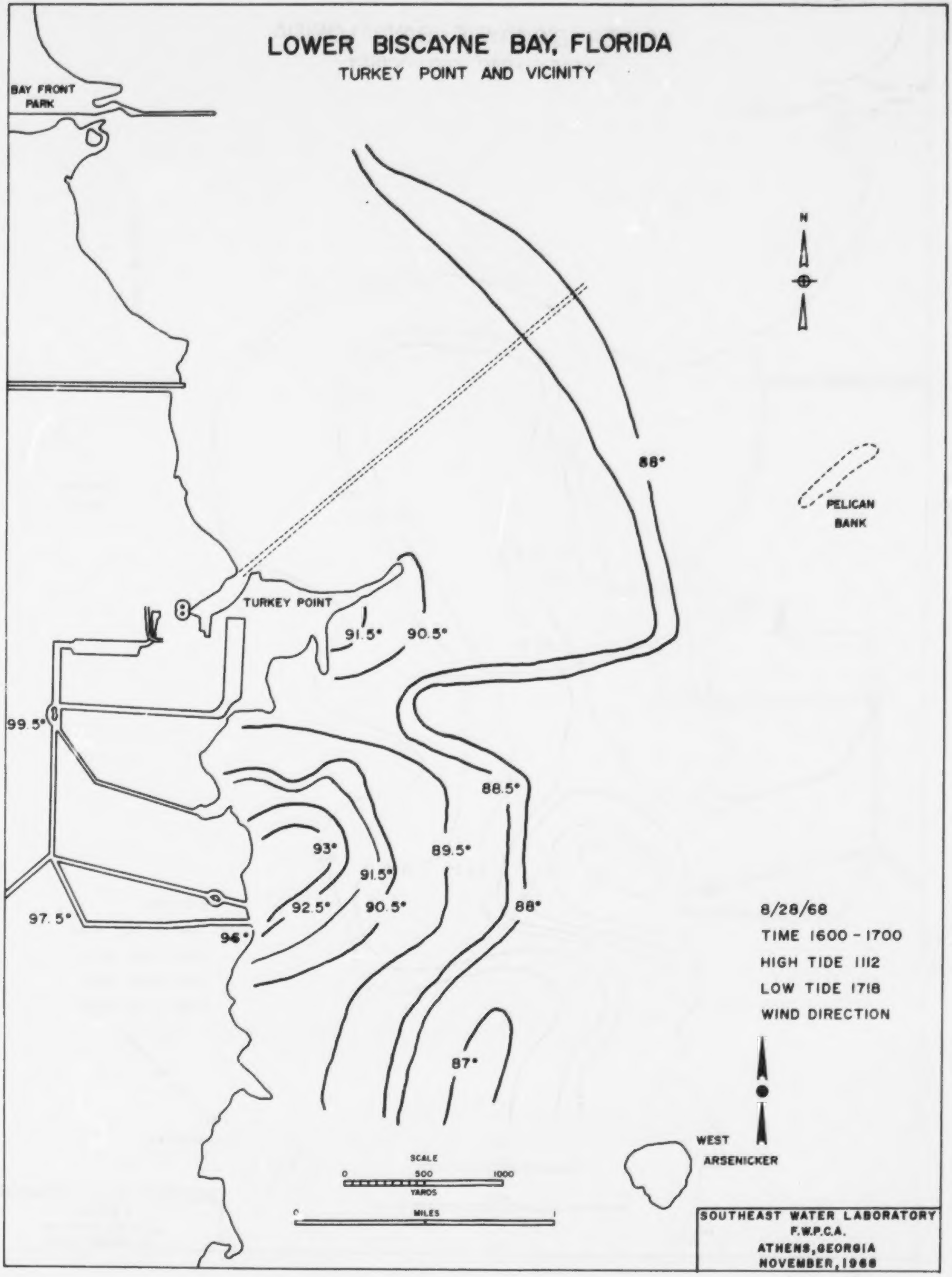

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
PELICAN BANK
TURKEY POINT
91.5°
90.5°
99.5°
88.5°
93°
89.5°
91.5°
97.5°
92.5°
90.5°
88°
96°
87°
8/28/68
TIME 1600 - 1700
HIGH TIDE 1112
LOW TIDE 1718
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 14

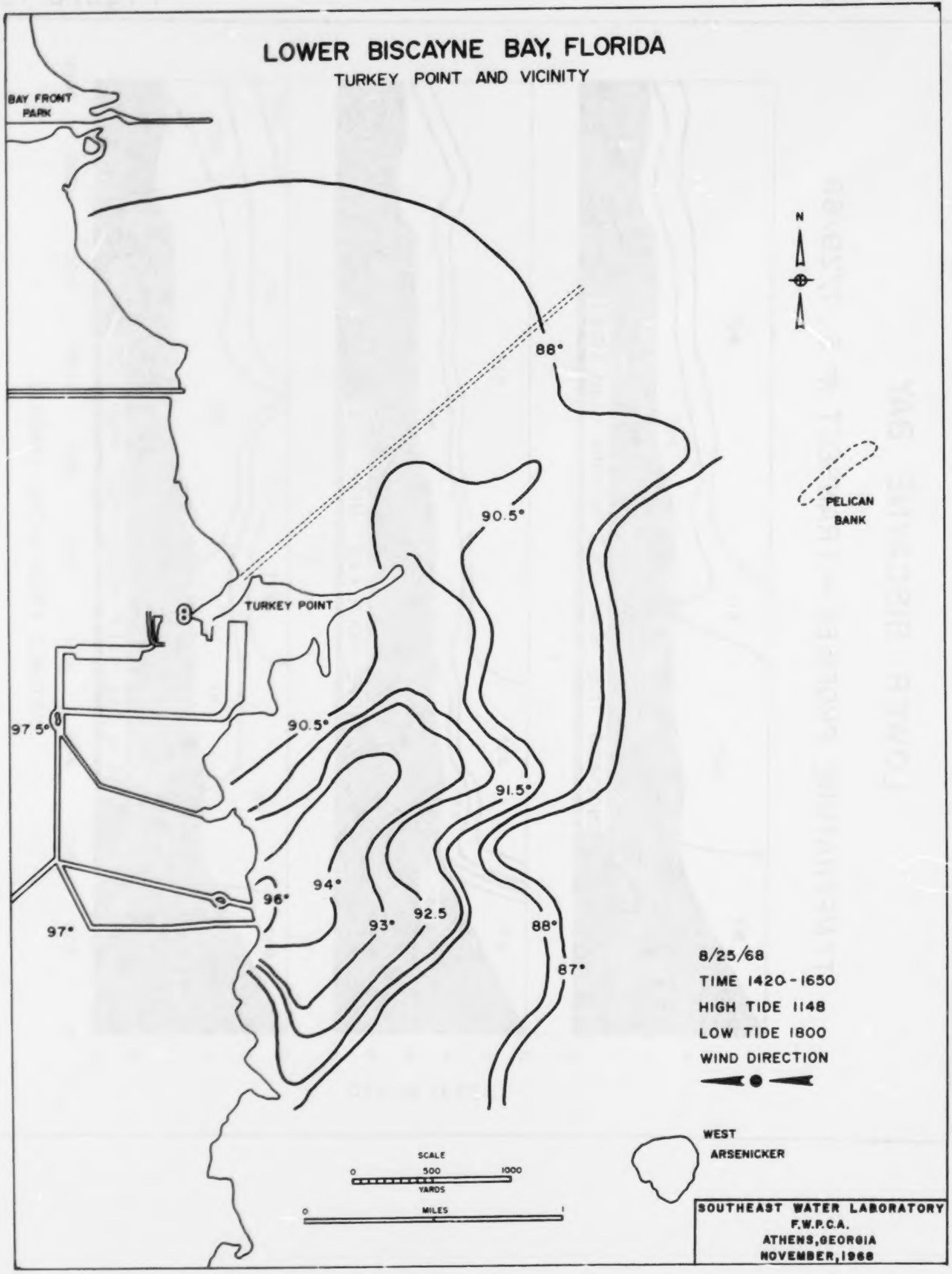
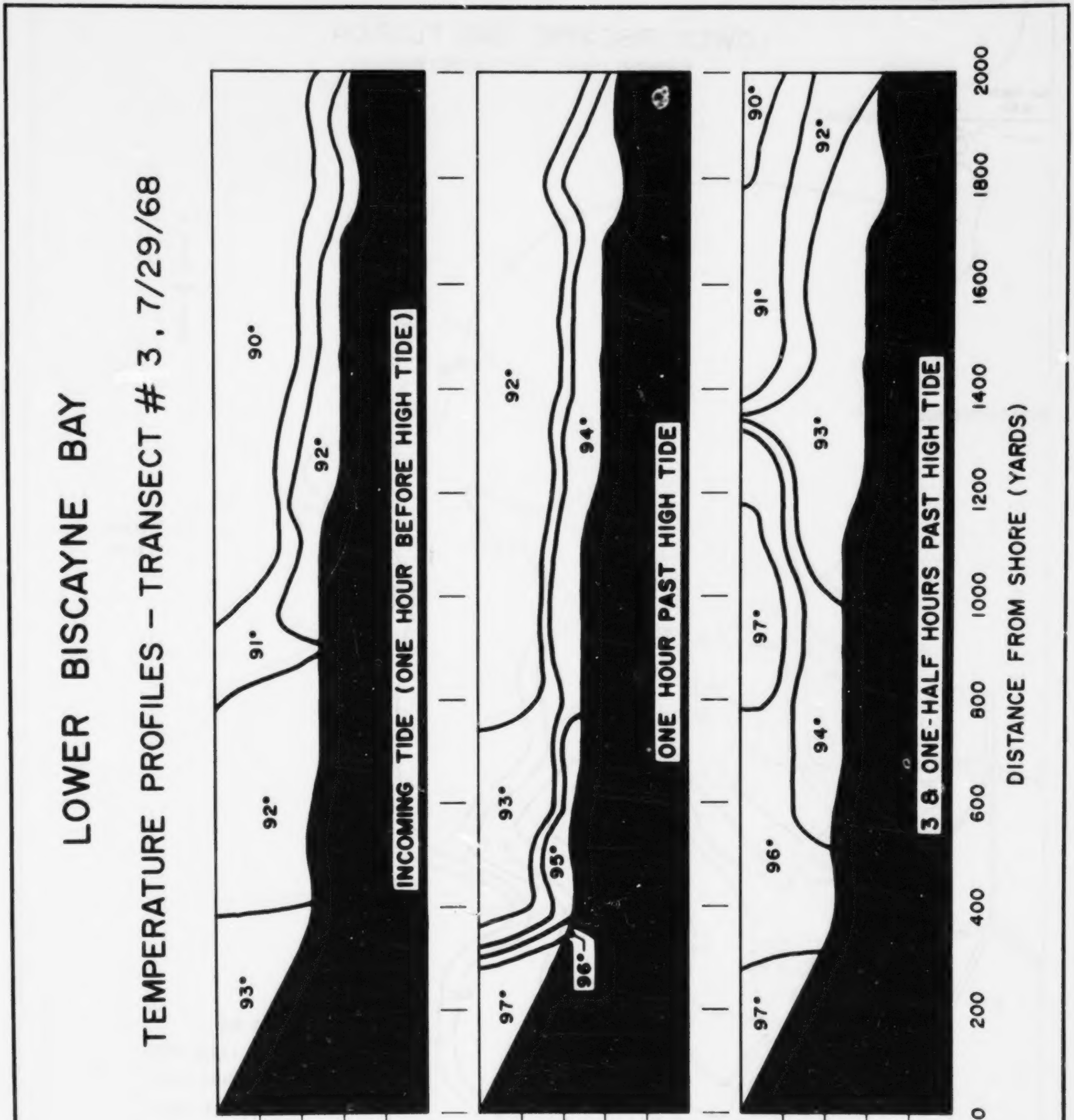

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
90.5°
PELICAN BANK
TURKEY POINT
90.5°
97.5°
91.5°
94°
96°
97°
93°
92.5
88°
87°
8/25/68
TIME 1420-1650
HIGH TIDE 1148
LOW TIDE 1800
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure 15



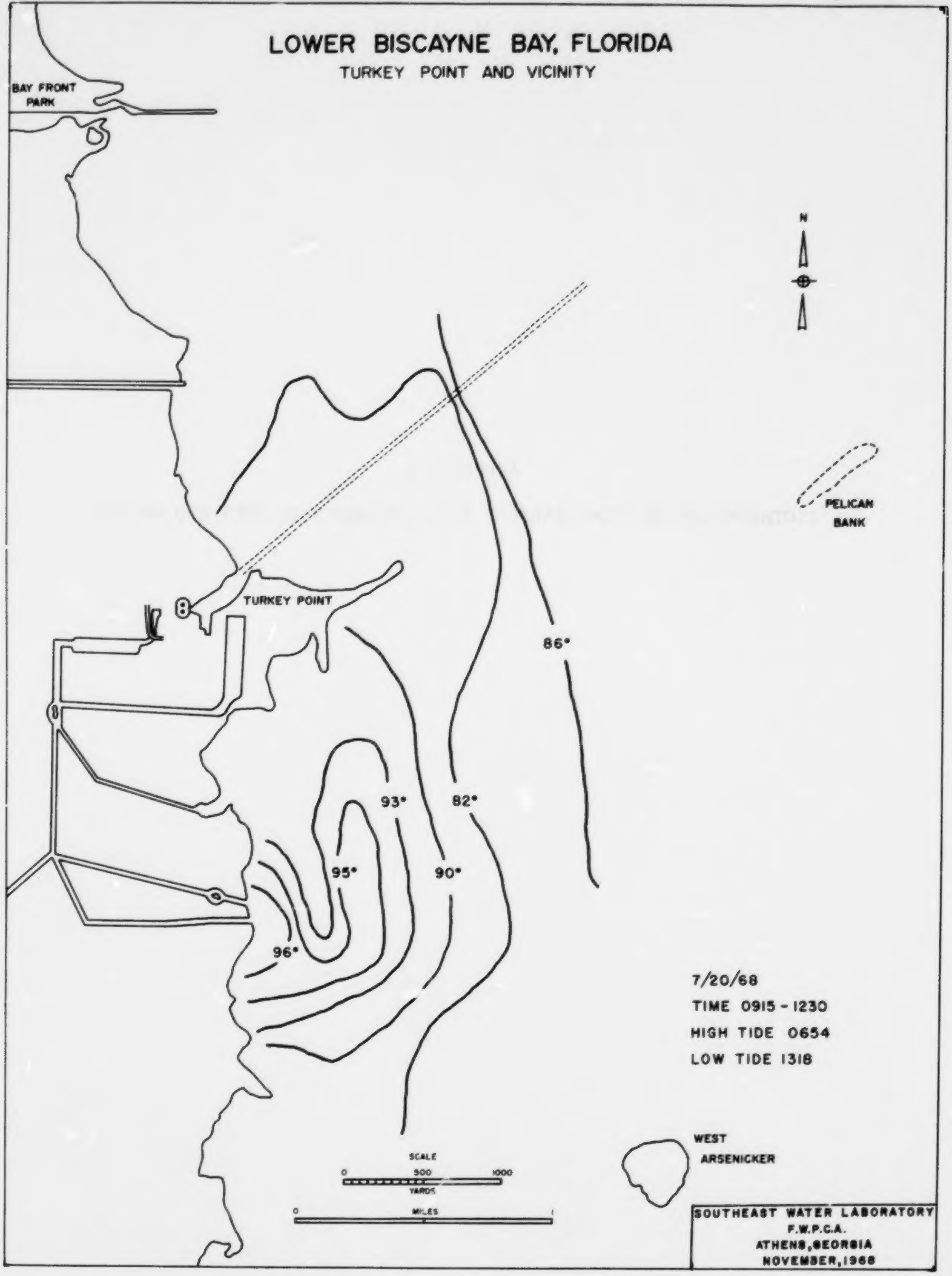
LOWER BISCAYNE BAY

TEMPERATURE PROFILES – TRANSECT # 3, 7/29/68

APPENDIX A

ISOTHERMS DRAWN FROM TRANSECT DATA COLLECTED IN JULY AND AUGUST

Figure A1



LOWER BISCAYNE BAY, FLORIDA

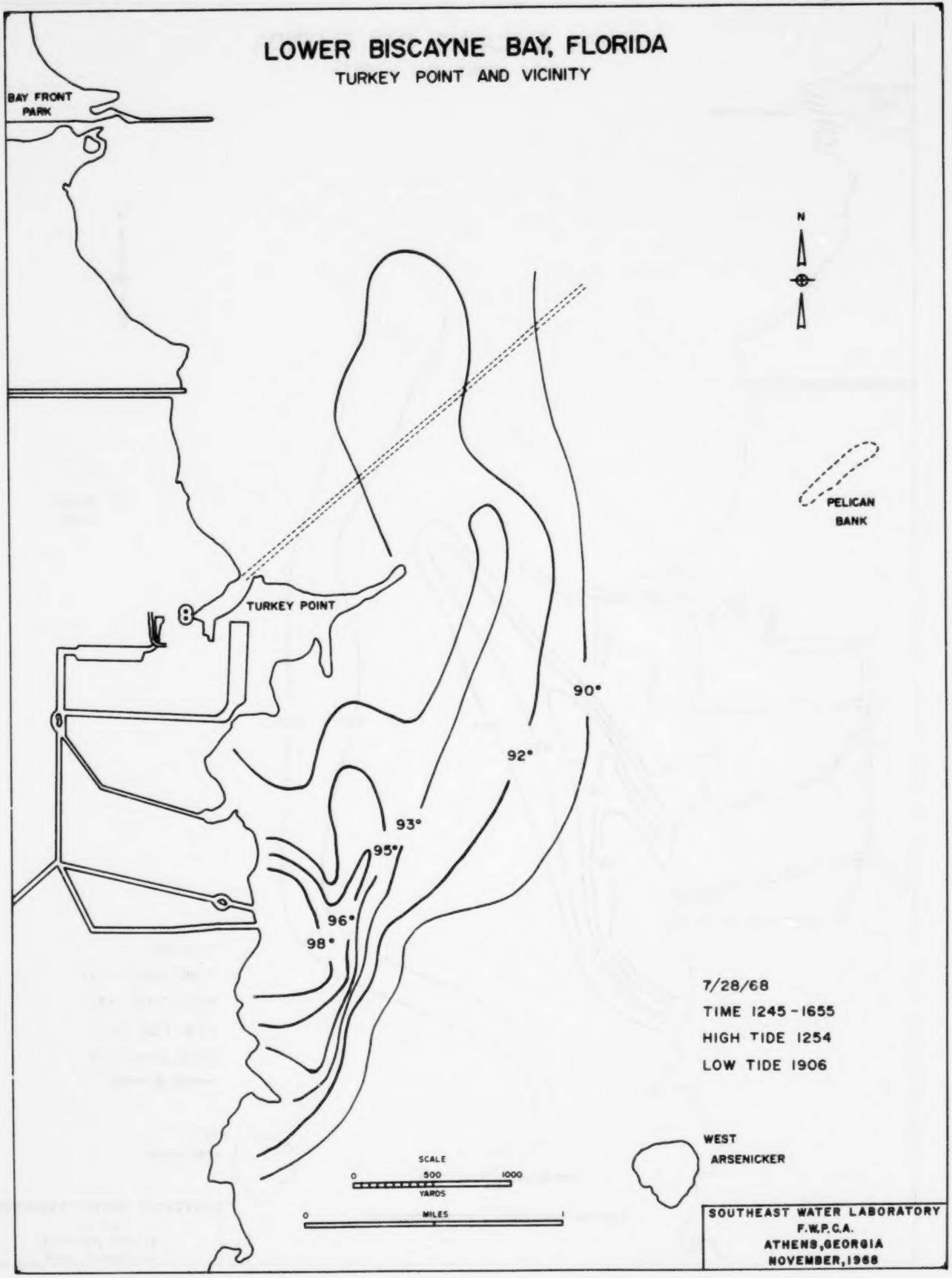
TURKEY POINT AND VICINITY

BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
86°
93°
82°
95°
90°
96°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

7/20/68
TIME 0915 - 1230
HIGH TIDE 0654
LOW TIDE 1318

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A2


LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
90°
92°
93°
95°
96°
98°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

7/28/68
TIME 1245 - 1655
HIGH TIDE 1254
LOW TIDE 1906

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A3

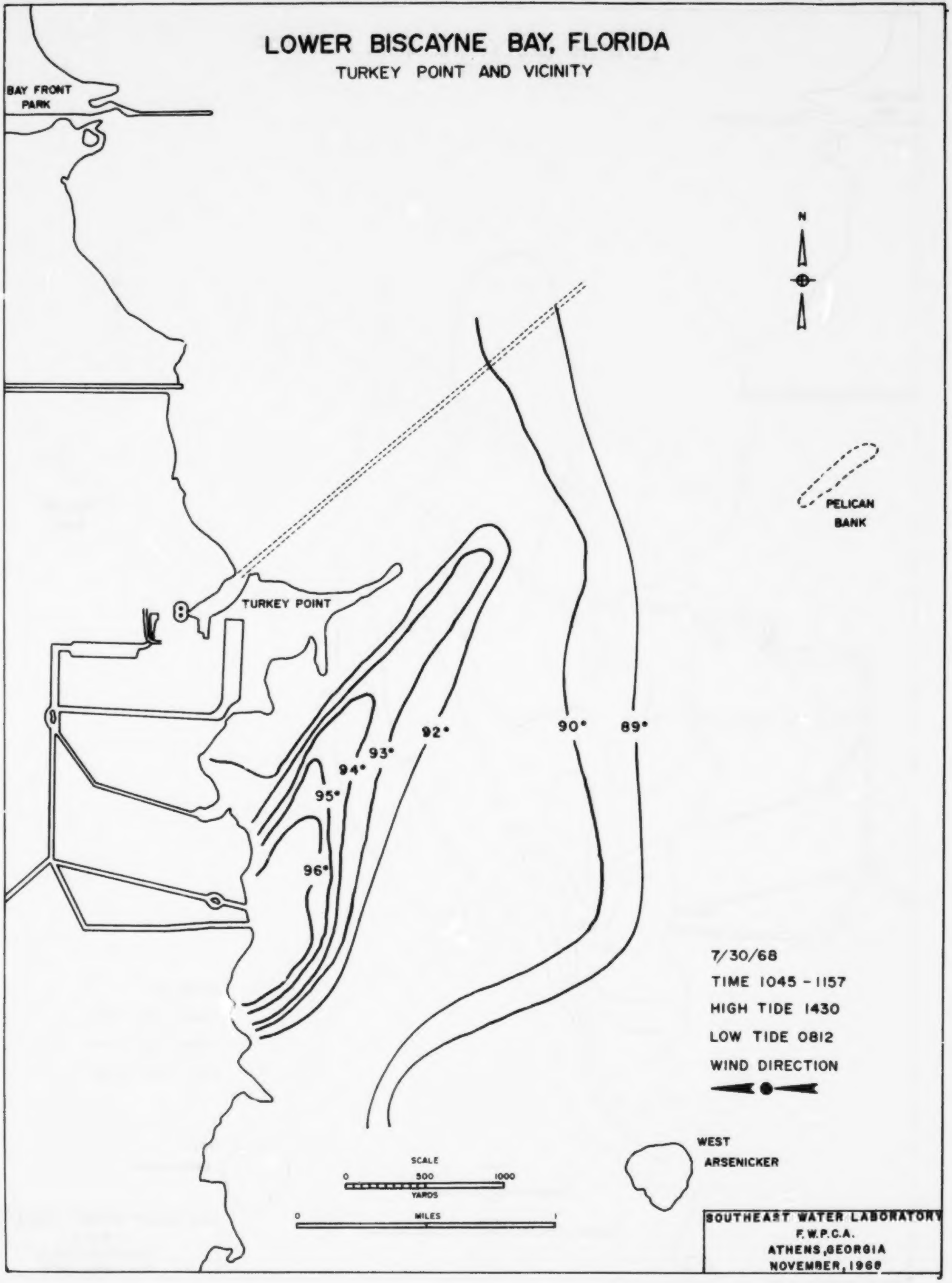
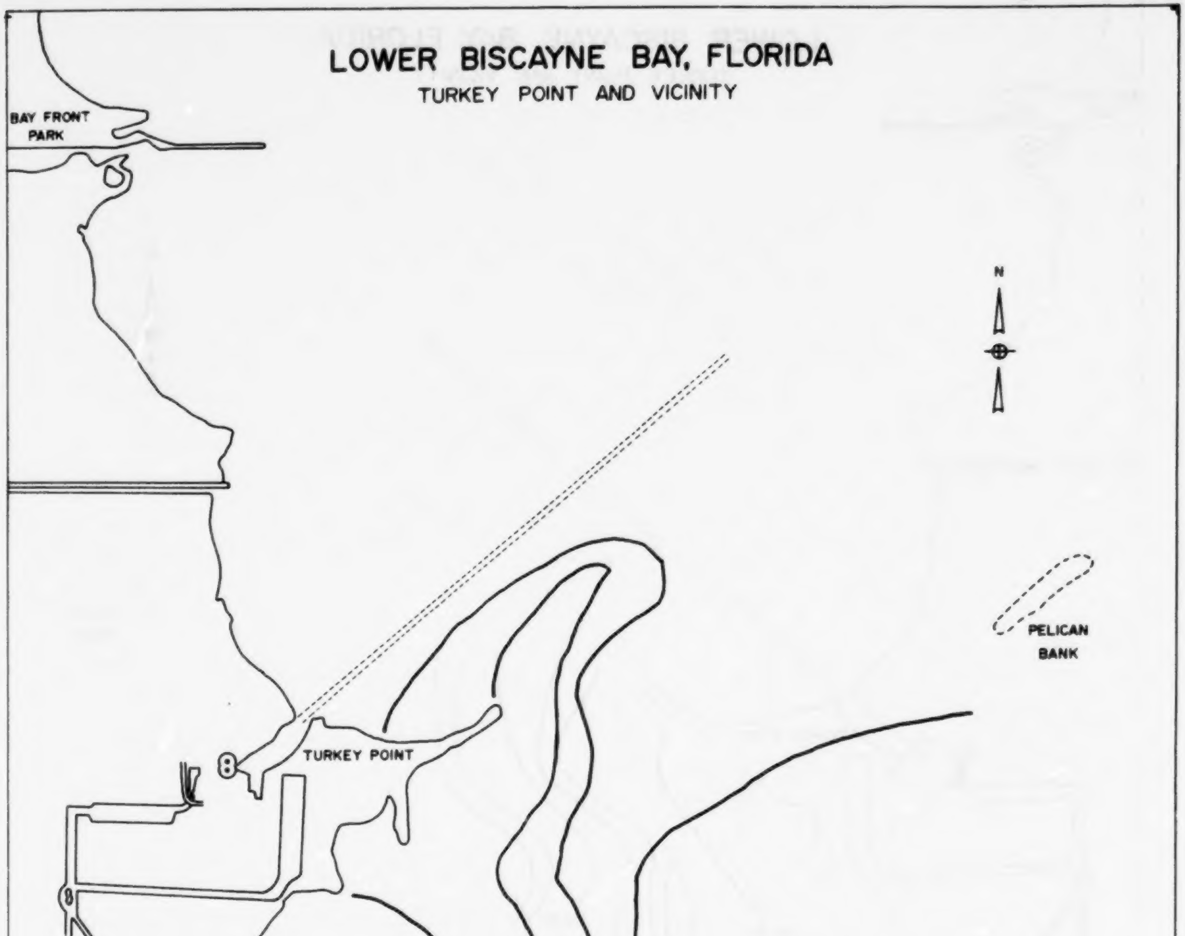

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
92°
90°
89°
93°
94°
95°
96°
7/30/68
TIME 1045 - 1157
HIGH TIDE 1430
LOW TIDE 0812
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A4



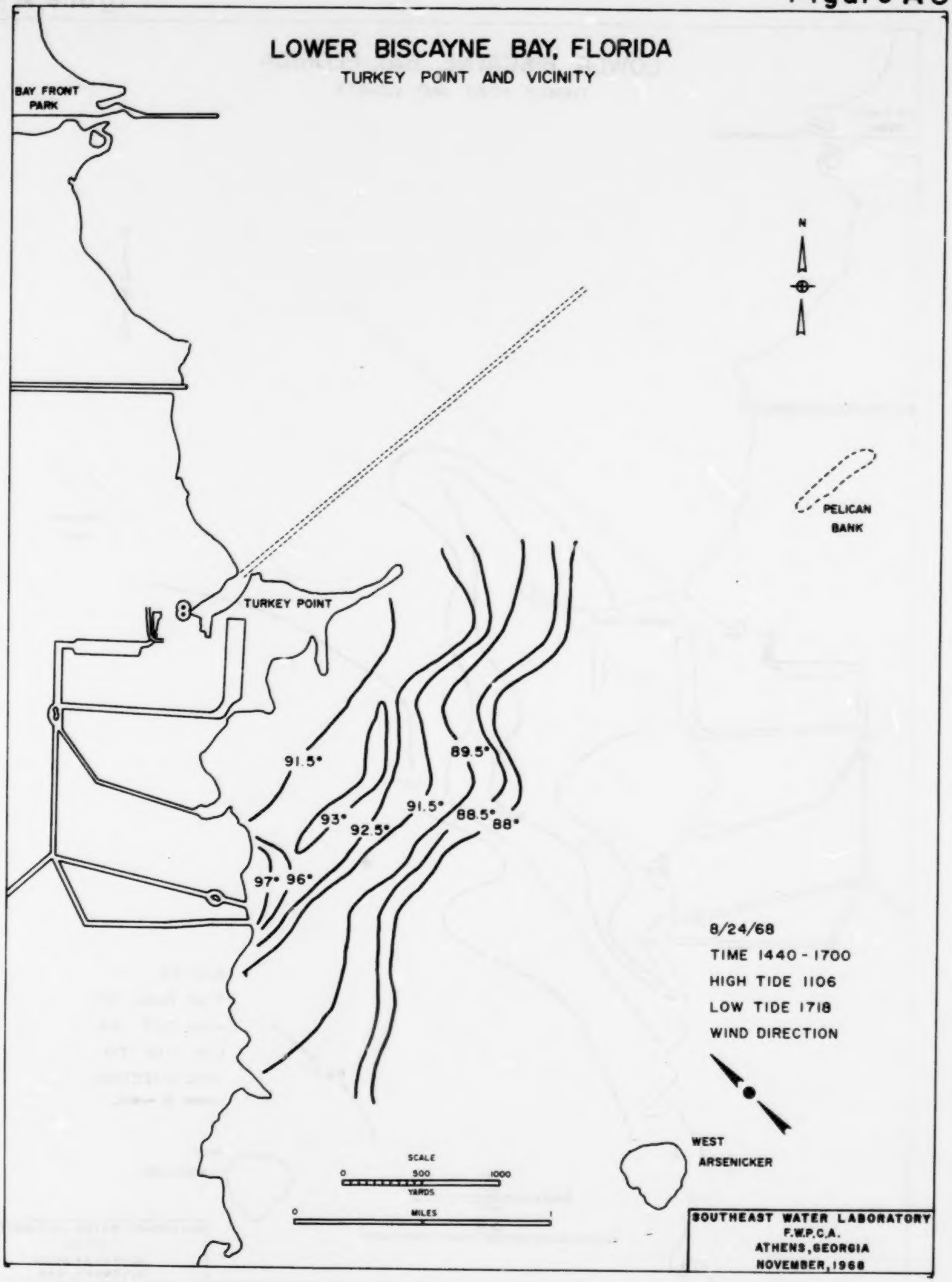
LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY

BAY FRONT PARK
N
TURKEY POINT
PELICAN BANK
85°
87°
88°
89.5
88°
93°
83.5°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

8/24/68
TIME 0850-1315
HIGH TIDE 1106
LOW TIDE 1718
WIND DIRECTION

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A5



LOWER BISCAYNE BAY, FLORIDA

TURKEY POINT AND VICINITY

8/24/68

TIME 1440 - 1700

HIGH TIDE 1106

LOW TIDE 1718

WIND DIRECTION

SOUTHEAST WATER LABORATORY

F.W.P.C.A.

ATHENS, GEORGIA

NOVEMBER, 1968

BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
91.5°
89.5°
93°
92.5°
91.5°
88.5°
88°
97°
96°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

Figure A6

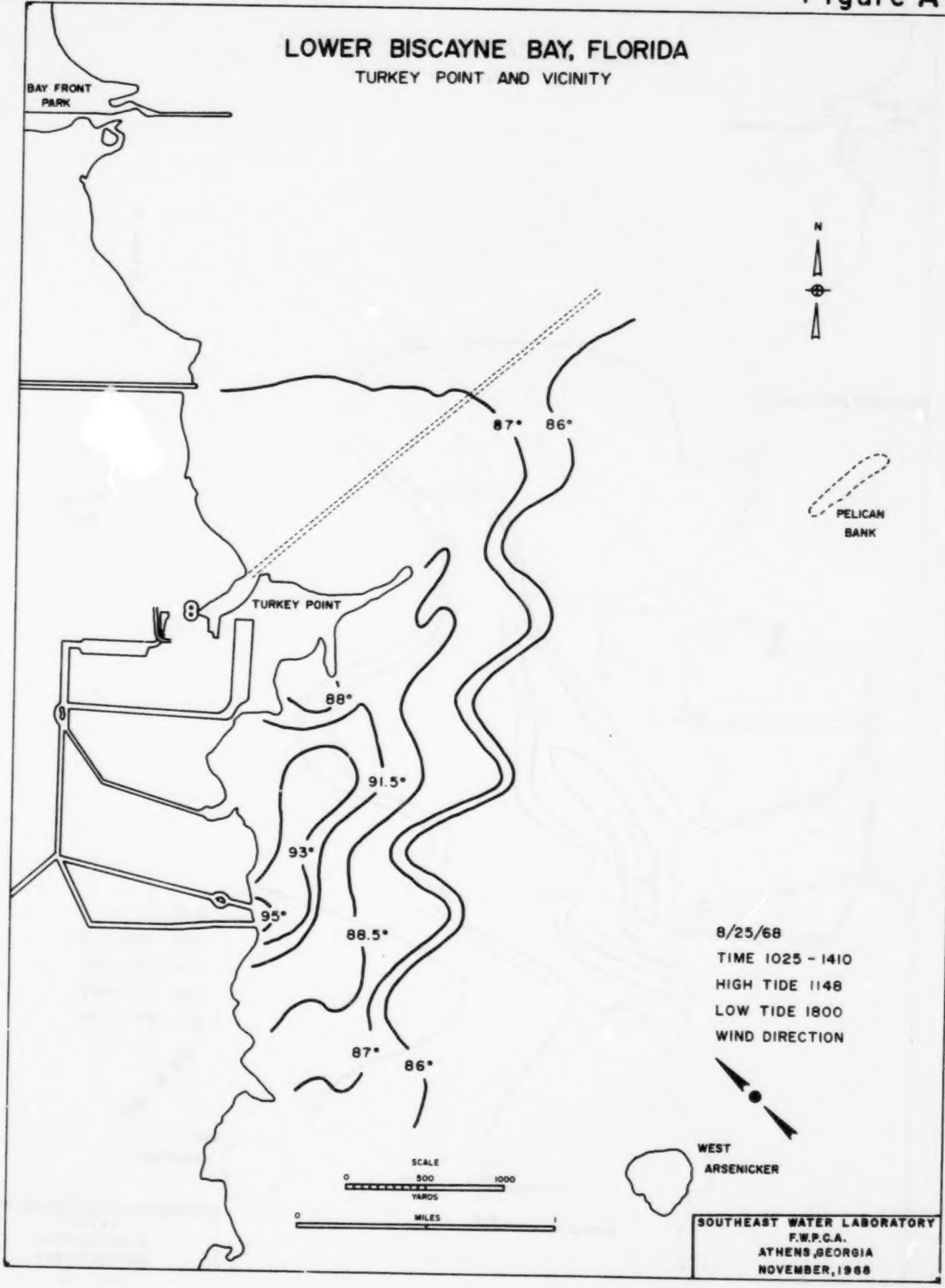

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
87°
86°
PELICAN BANK
TURKEY POINT
88°
91.5°
93°
95°
88.5°
87°
86°
8/25/68
TIME 1025 - 1410
HIGH TIDE 1148
LOW TIDE 1800
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A7

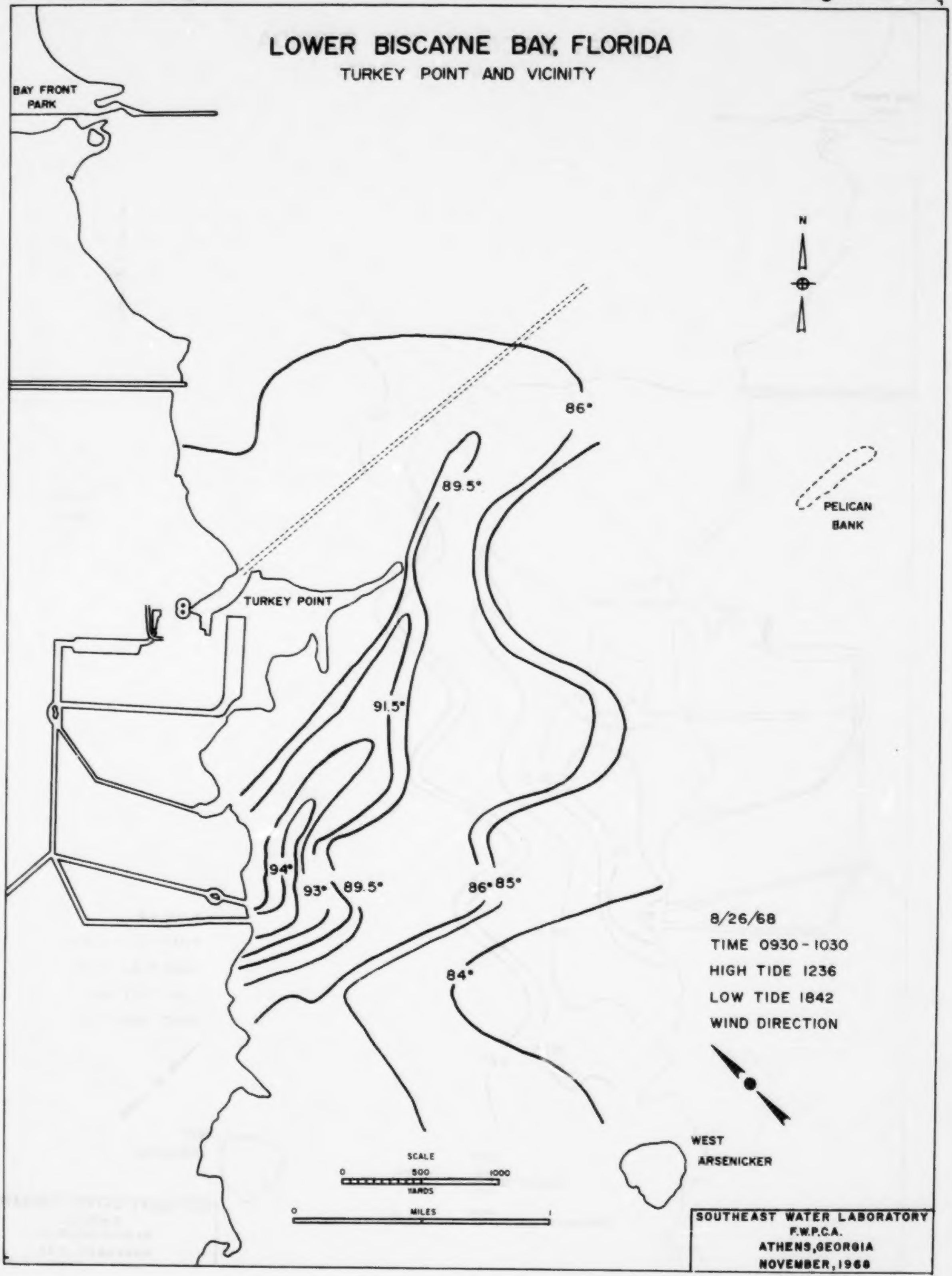
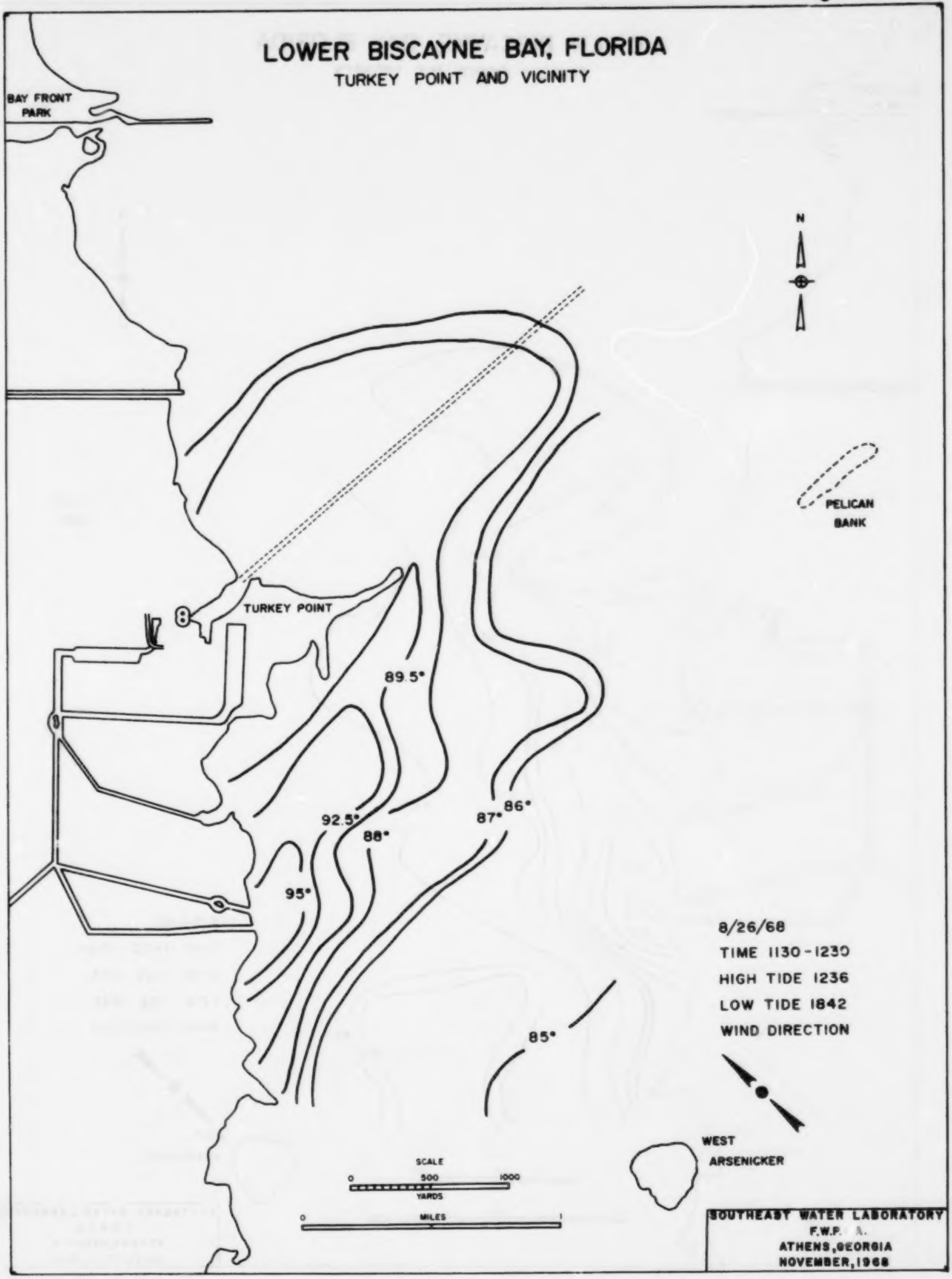

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
TURKEY POINT
PELICAN BANK
86°
89.5°
91.5°
94°
93°
89.5°
86°
85°
84°
8/26/68
TIME 0930 - 1030
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A8



LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY

8/26/68
TIME 1130-1230
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION

SOUTHEAST WATER LABORATORY
F.W.P. A.
ATHENS, GEORGIA
NOVEMBER, 1968

BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
89.5°
92.5°
88°
87°
86°
95°
85°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

Figure A9

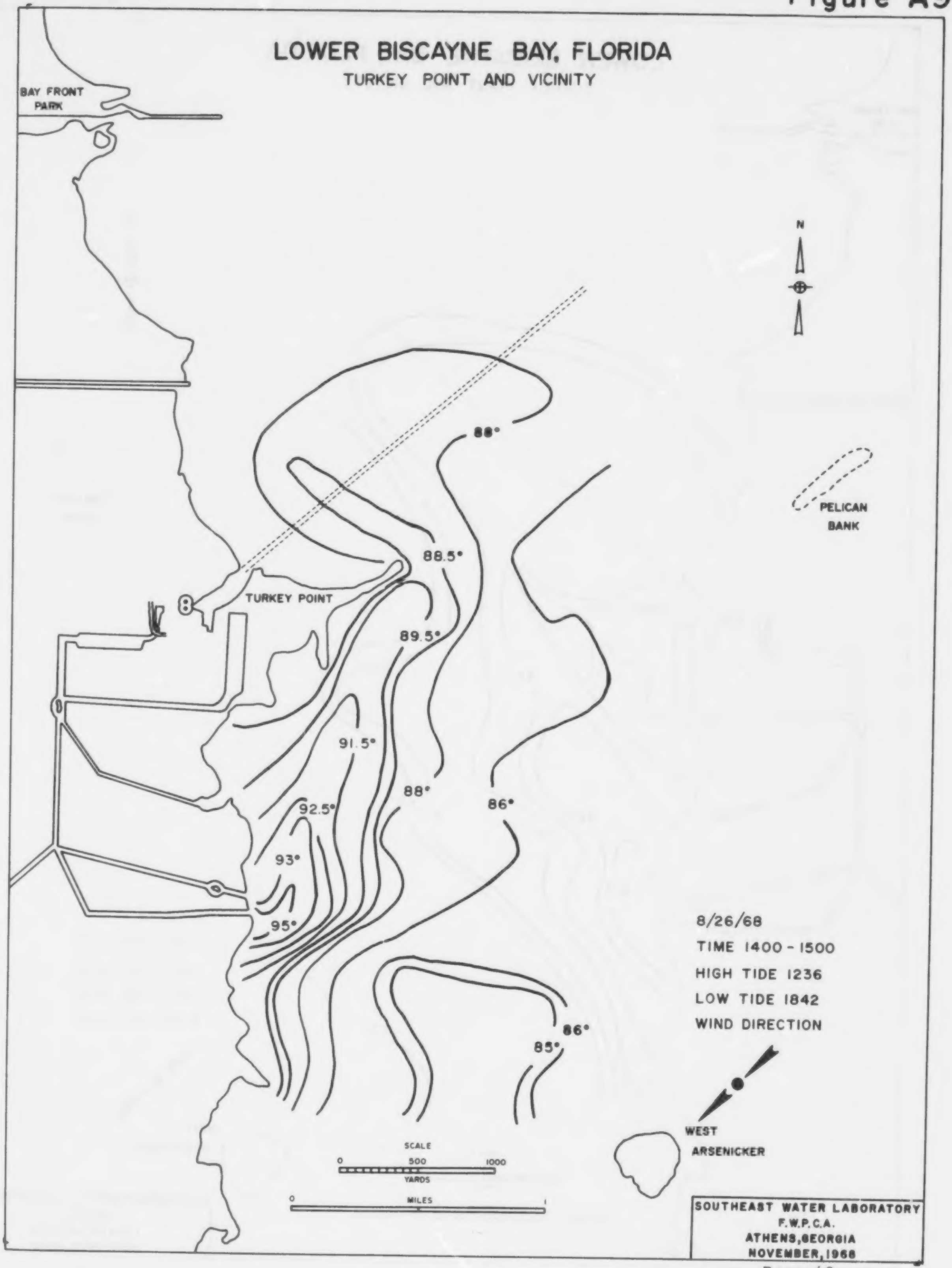

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
PELICAN BANK
88.5°
TURKEY POINT
89.5°
91.5°
88°
86°
92.5°
93°
95°
8/26/68
TIME 1400 - 1500
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION
86°
85°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A10

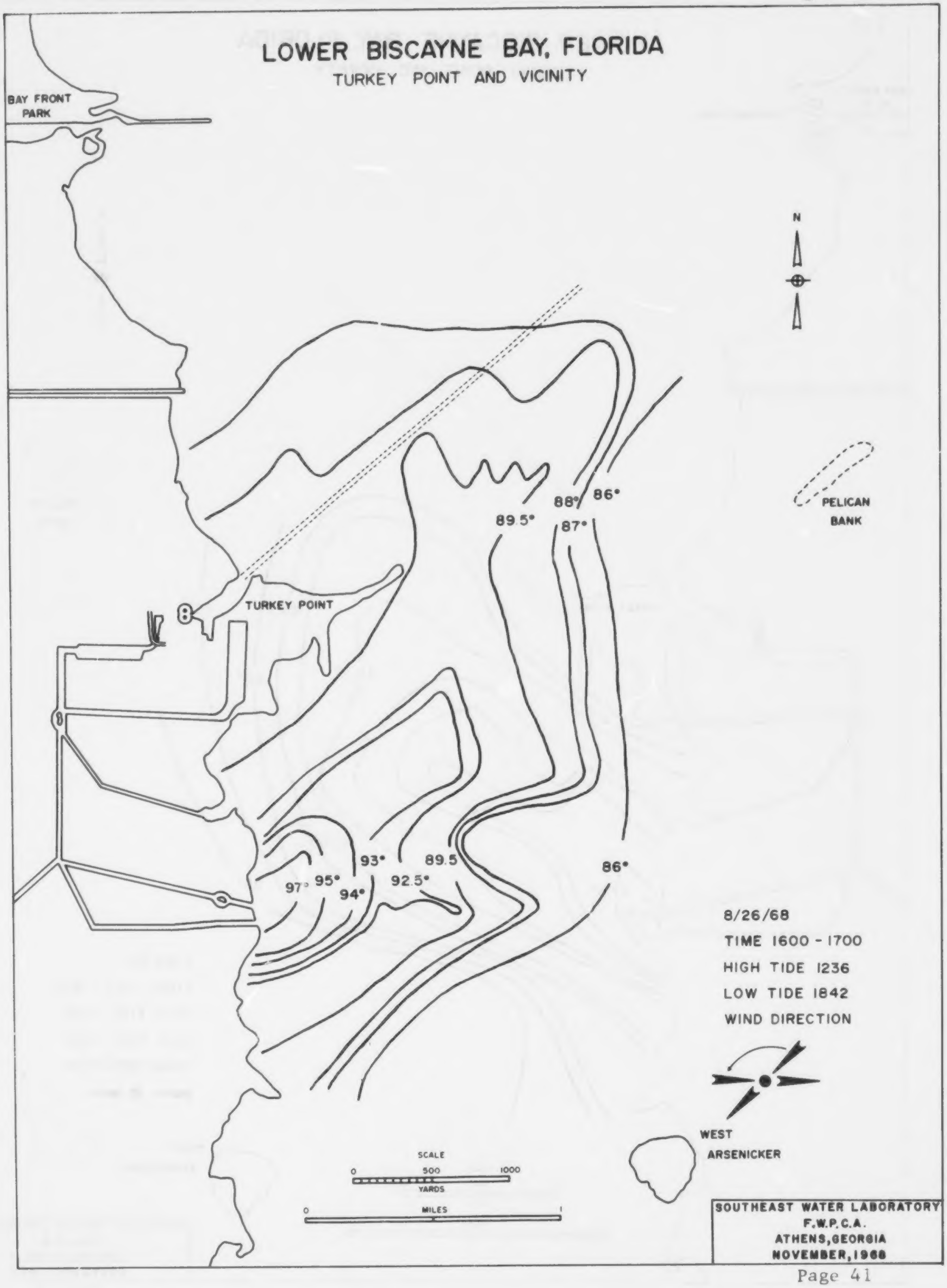

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
TURKEY POINT
PELICAN BANK
88°
86°
89.5°
87°
93°
89.5
86°
97°
95°
94°
92.5°
8/26/68
TIME 1600 - 1700
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A11

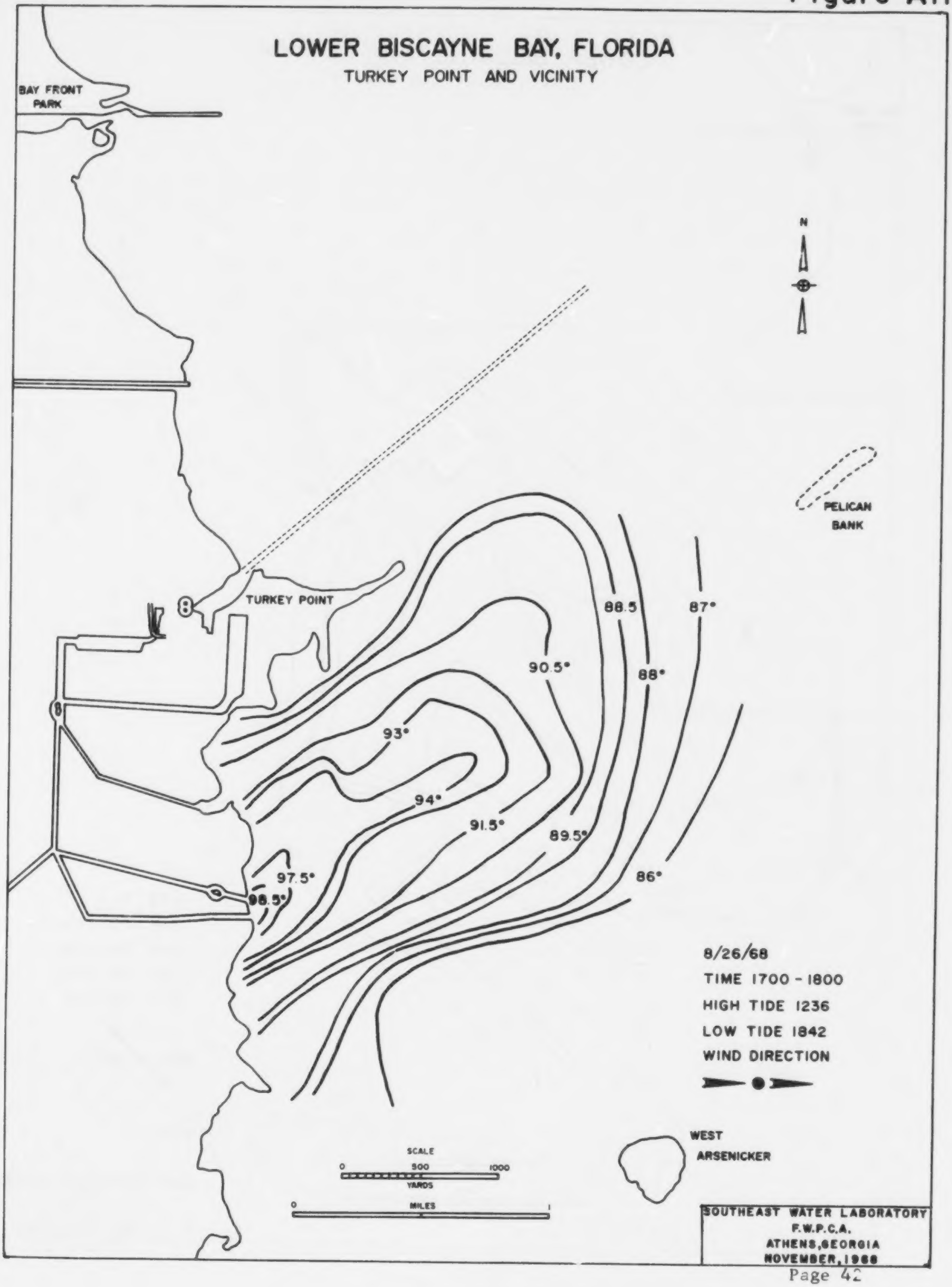
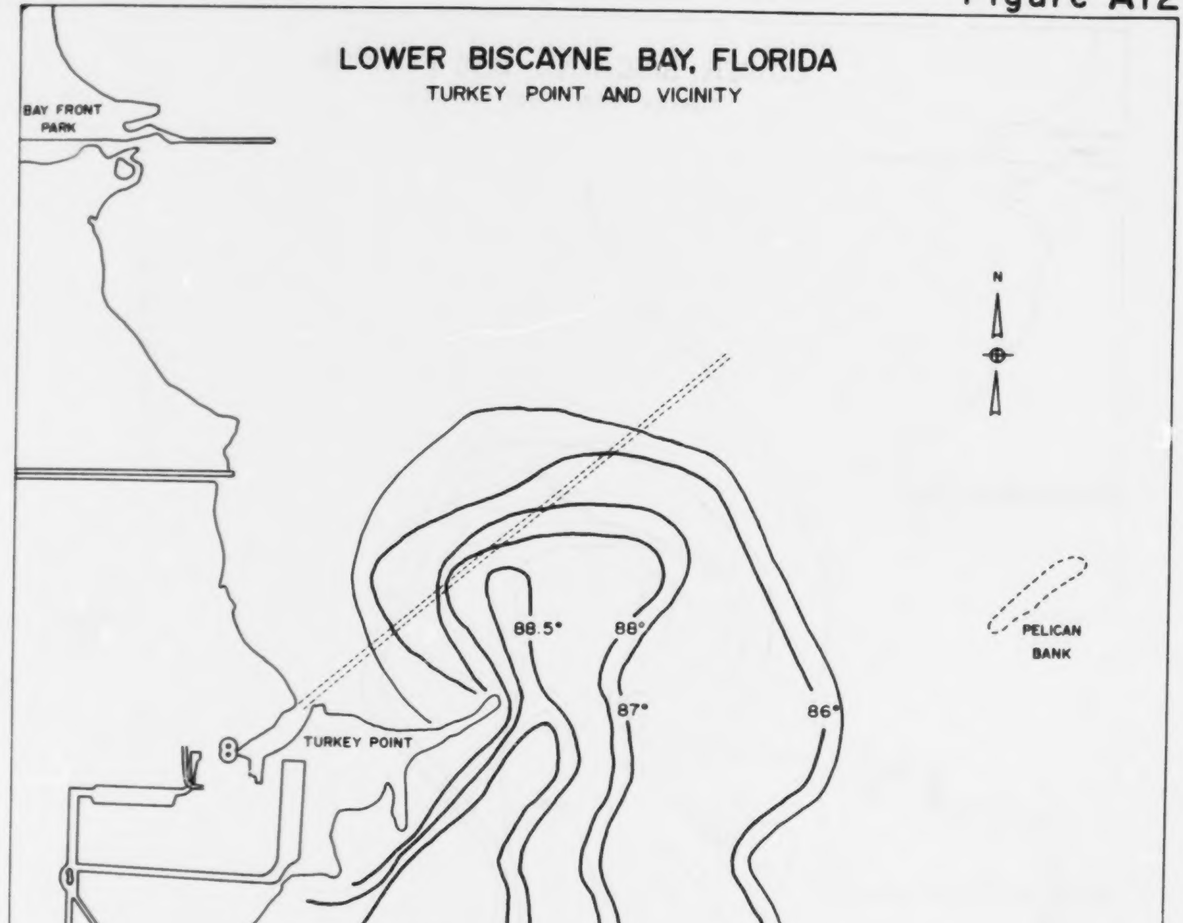

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
TURKEY POINT
PELICAN BANK
88.5
87°
90.5°
88°
93°
94°
91.5°
89.5°
97.5°
98.5°
86°
8/26/68
TIME 1700 - 1800
HIGH TIDE 1236
LOW TIDE 1842
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A12



LOWER BISCAYNE BAY, FLORIDA

TURKEY POINT AND VICINITY

BAY FRONT PARK
N
TURKEY POINT
88.5°
88°
87°
86°
PELICAN BANK
90.5°
89.5°
88.5°
85°
88°
87°
86°
84°
84°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

8/27/68
TIME 0900-1000
HIGH TIDE 1318
LOW TIDE 1930
WIND DIRECTION

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A13

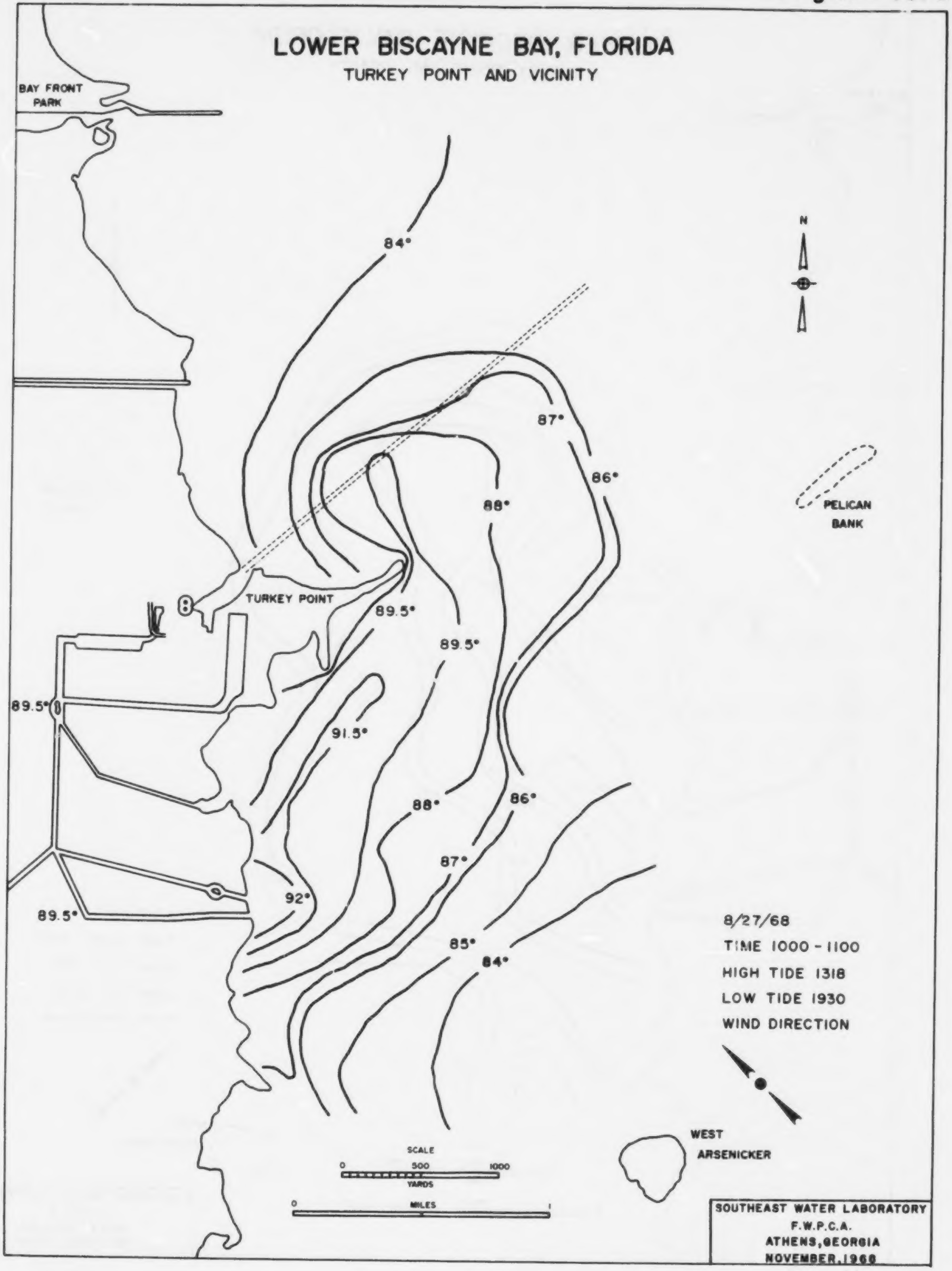

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
84°
87°
86°
88°
PELICAN BANK
TURKEY POINT
89.5°
89.5°
89.5°
91.5°
88°
86°
87°
92°
89.5°
85°
84°
N
8/27/68
TIME 1000 - 1100
HIGH TIDE 1318
LOW TIDE 1930
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A14

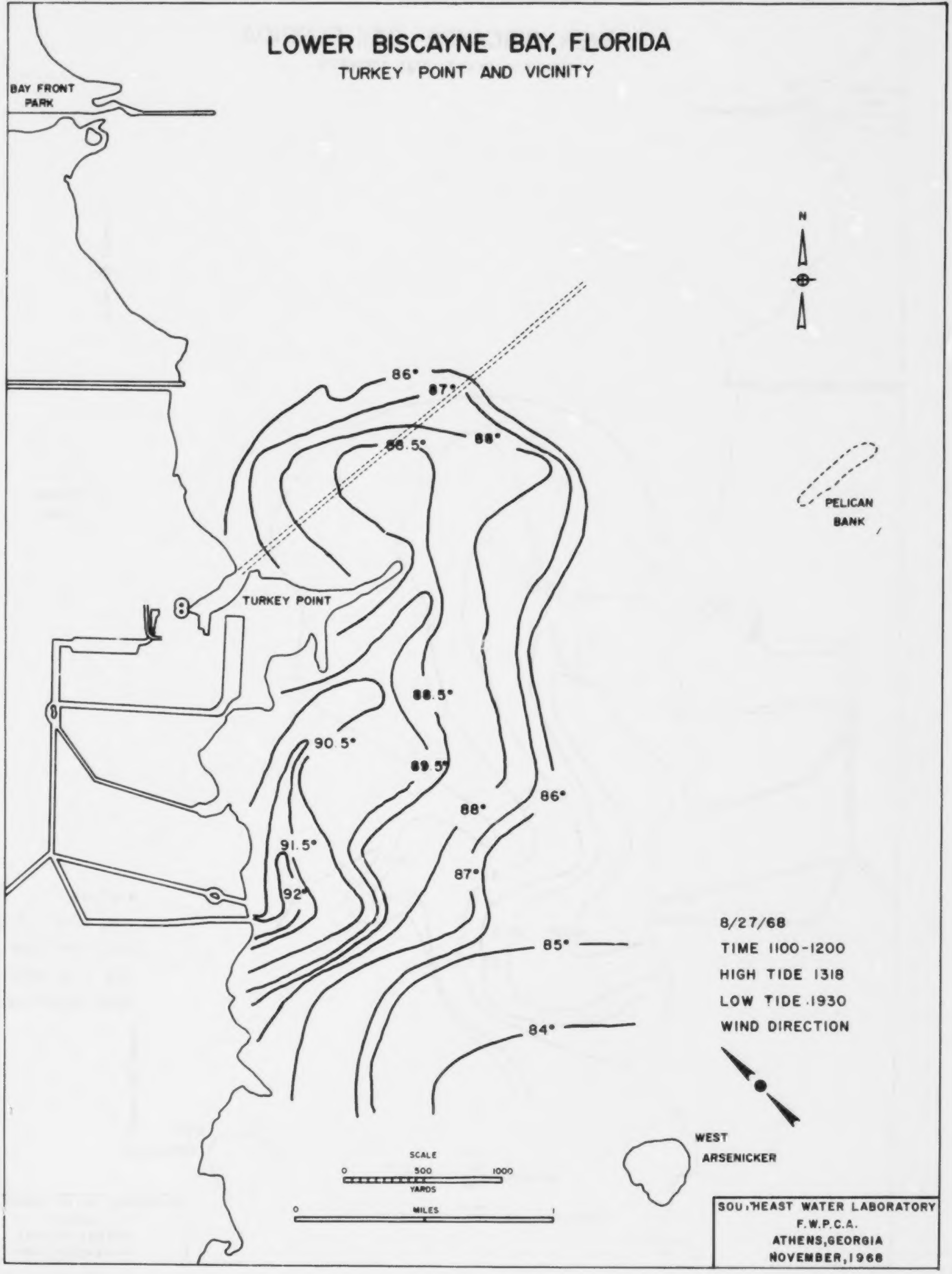
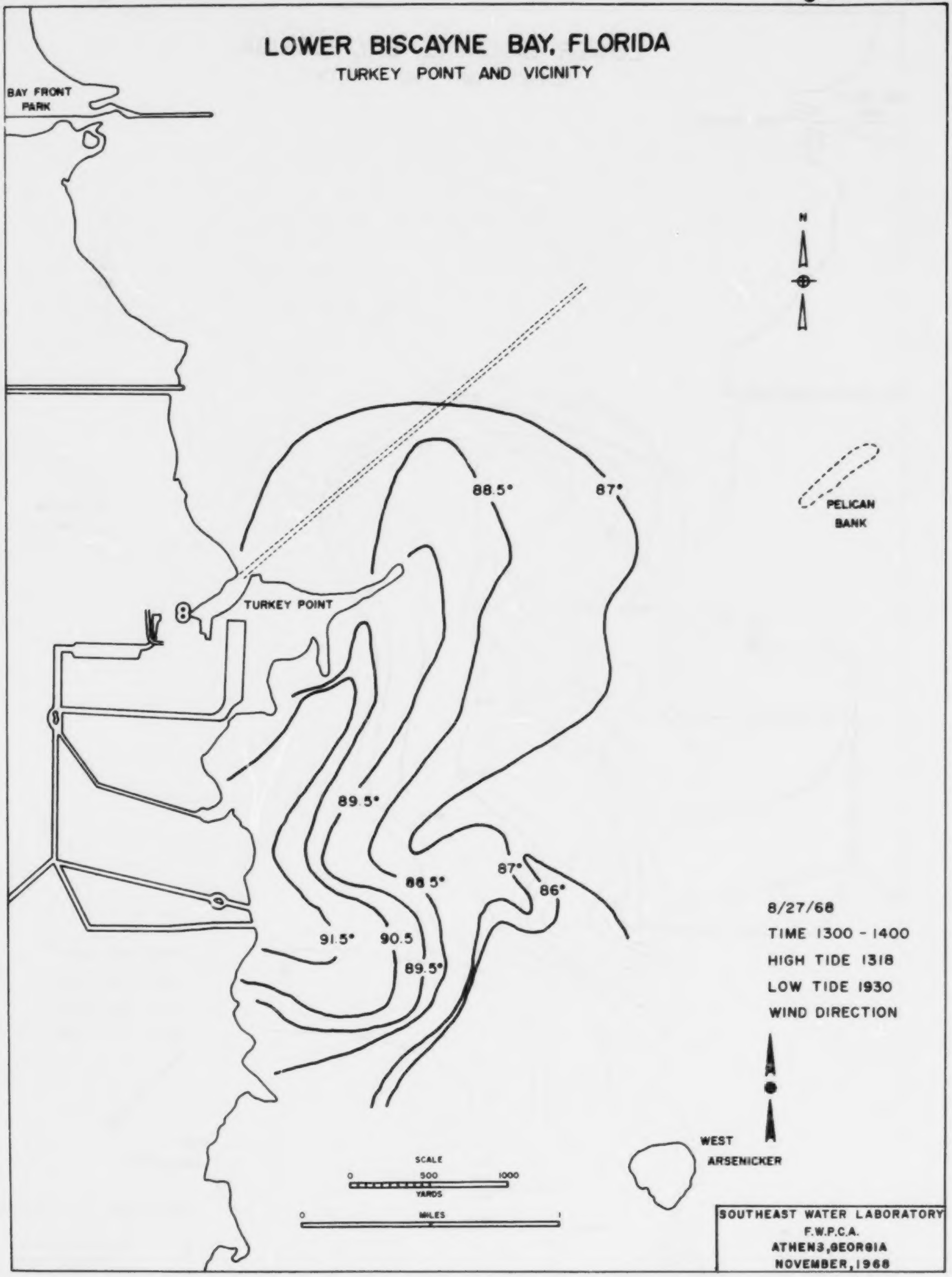

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
86°
87°
88.5°
88°
88.5°
90.5°
89.5°
86°
88°
91.5°
92°
87°
85°
84°
8/27/68
TIME 1100-1200
HIGH TIDE 1318
LOW TIDE 1930
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A15



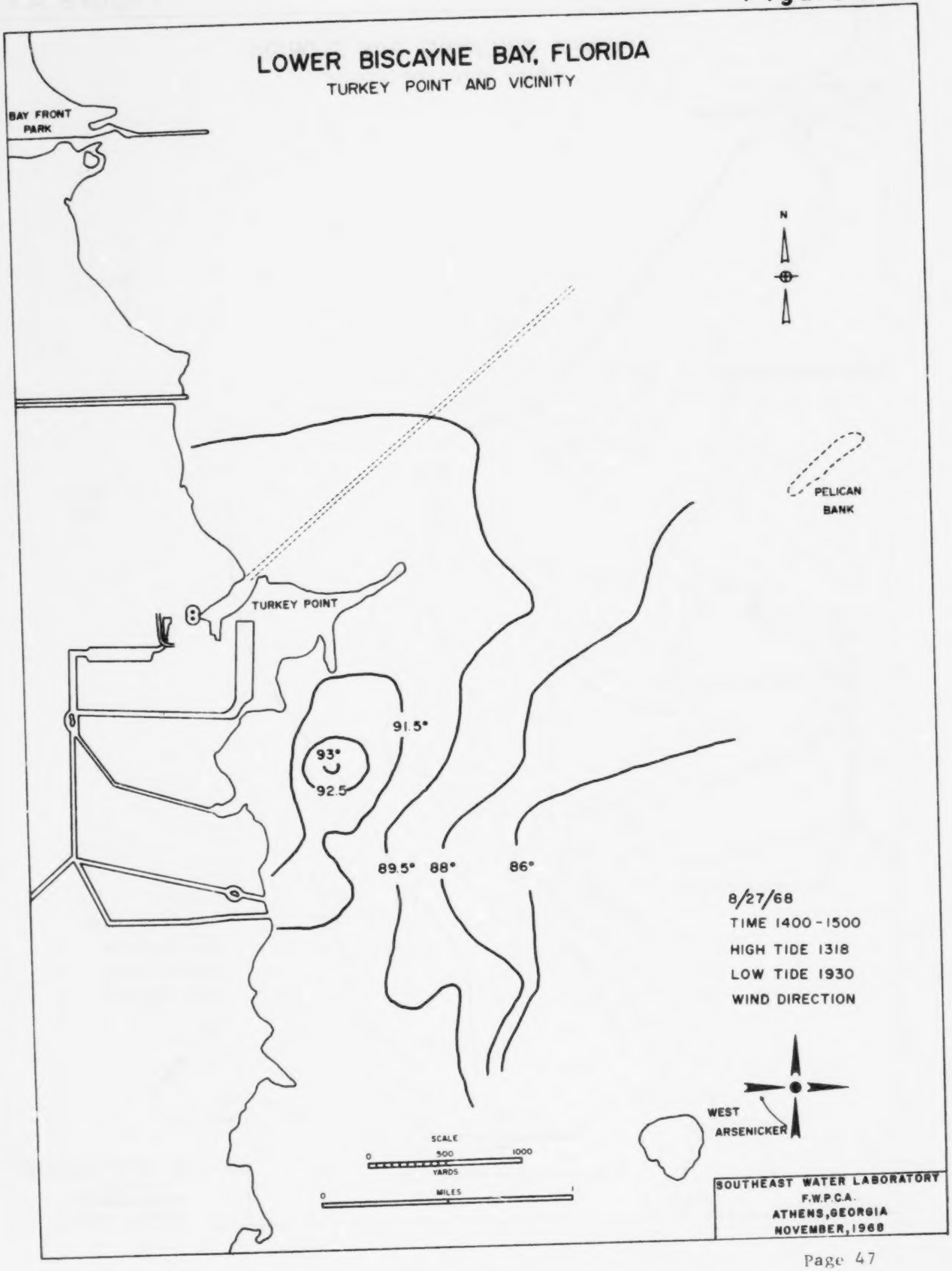
LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY

8/27/68
TIME 1300 - 1400
HIGH TIDE 1318
LOW TIDE 1930
WIND DIRECTION

SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

BAY FRONT PARK
N
88.5°
87°
PELICAN BANK
TURKEY POINT
89.5°
87°
88.5°
86°
91.5°
90.5
89.5°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

Figure A16



LOWER BISCAYNE BAY, FLORIDA

TURKEY POINT AND VICINITY

8/27/68

TIME 1400-1500

HIGH TIDE 1318

LOW TIDE 1930

WIND DIRECTION

SOUTHEAST WATER LABORATORY

F.W.P.C.A.

ATHENS, GEORGIA

NOVEMBER, 1968

BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
91.5°
93°
92.5
89.5°
88°
86°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

Figure A17

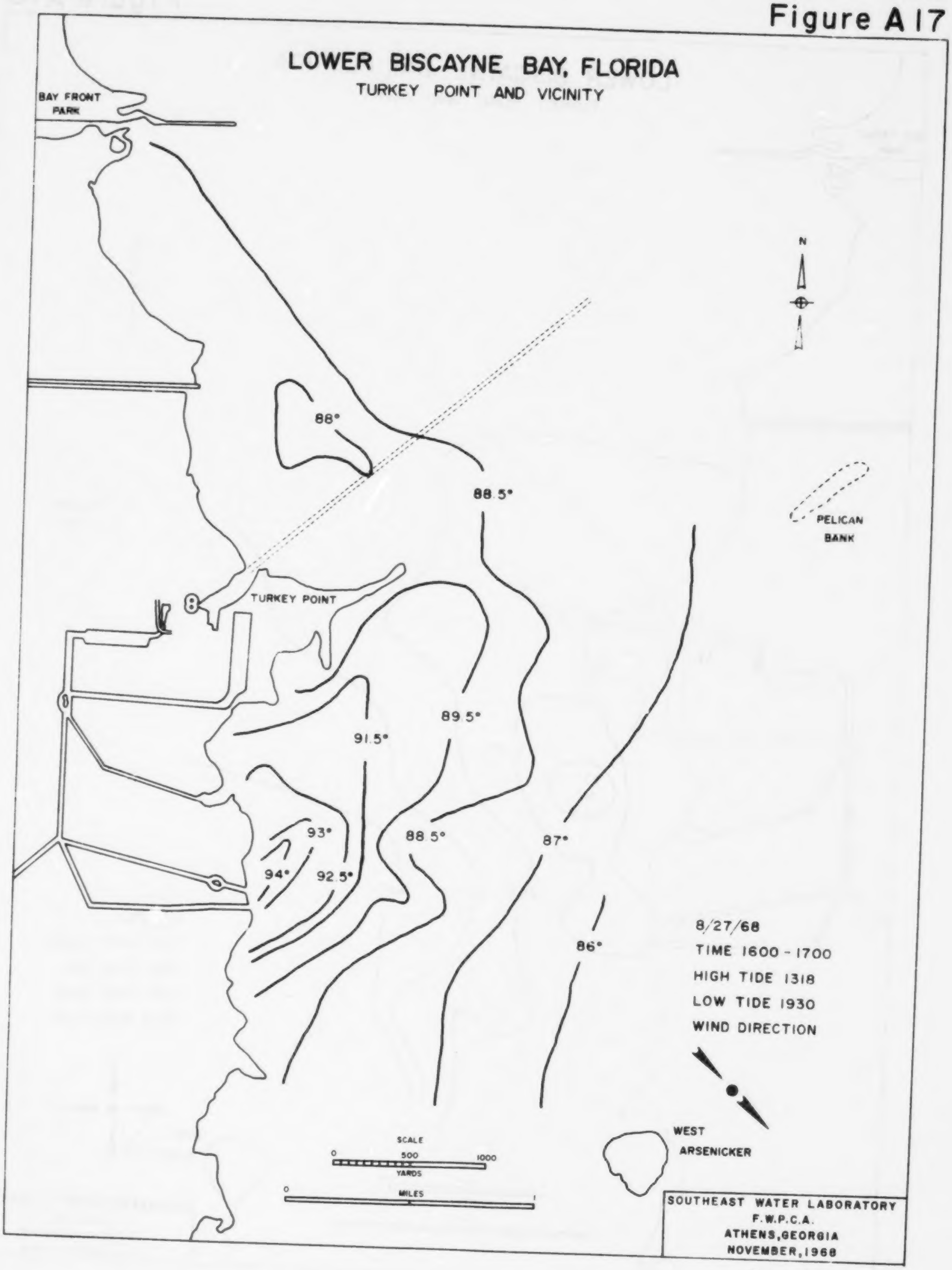

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
88.5°
PELICAN BANK
TURKEY POINT
89.5°
91.5°
93°
88.5°
87°
94°
92.5°
86°
8/27/68
TIME 1600 - 1700
HIGH TIDE 1318
LOW TIDE 1930
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A18

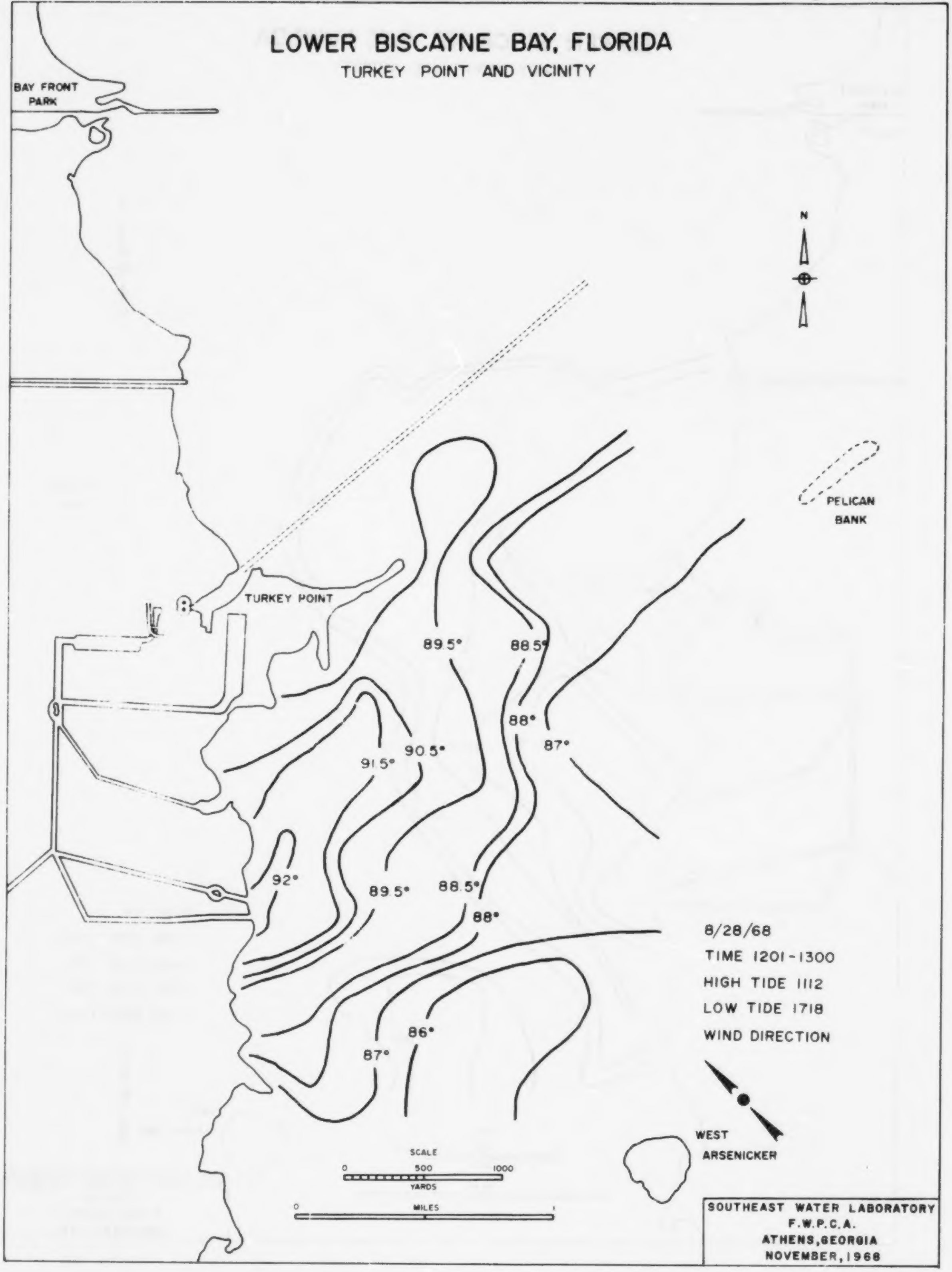
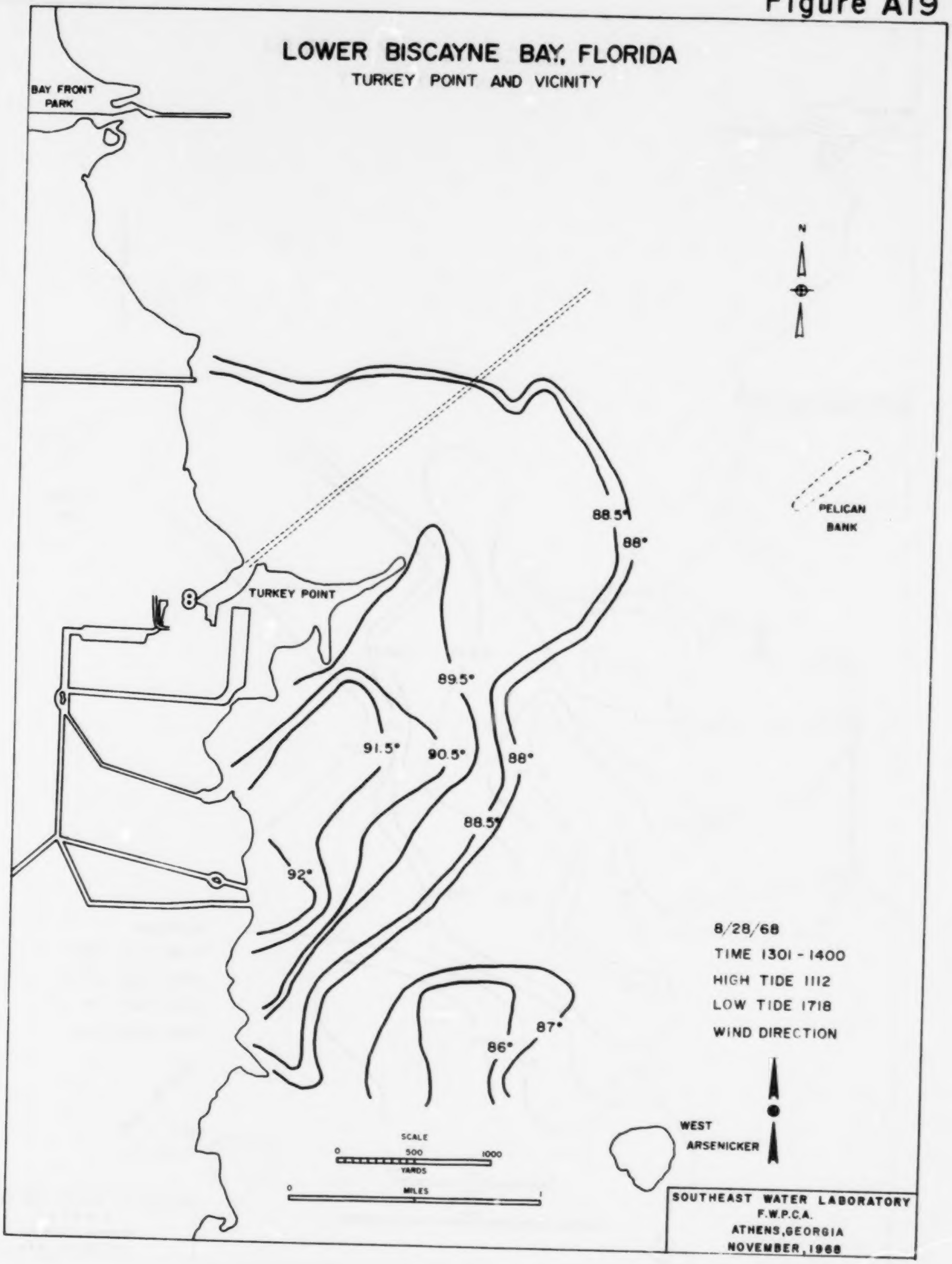

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
TURKEY POINT
N
PELICAN BANK
89.5°
88.5°
88°
87°
91.5°
90.5°
92°
89.5°
88.5°
88°
86°
87°
8/28/68
TIME 1201-1300
HIGH TIDE 1112
LOW TIDE 1718
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A19



LOWER BISCAYNE BAY, FLORIDA

TURKEY POINT AND VICINITY

8/28/68

TIME 1301 - 1400

HIGH TIDE 1112

LOW TIDE 1718

WIND DIRECTION

SOUTHEAST WATER LABORATORY

F.W.P.C.A.

ATHENS, GEORGIA

NOVEMBER, 1968

BAY FRONT PARK
N
PELICAN BANK
88.5°
88°
TURKEY POINT
89.5°
91.5°
90.5°
88°
88.5°
92°
87°
86°
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1

Figure A 20

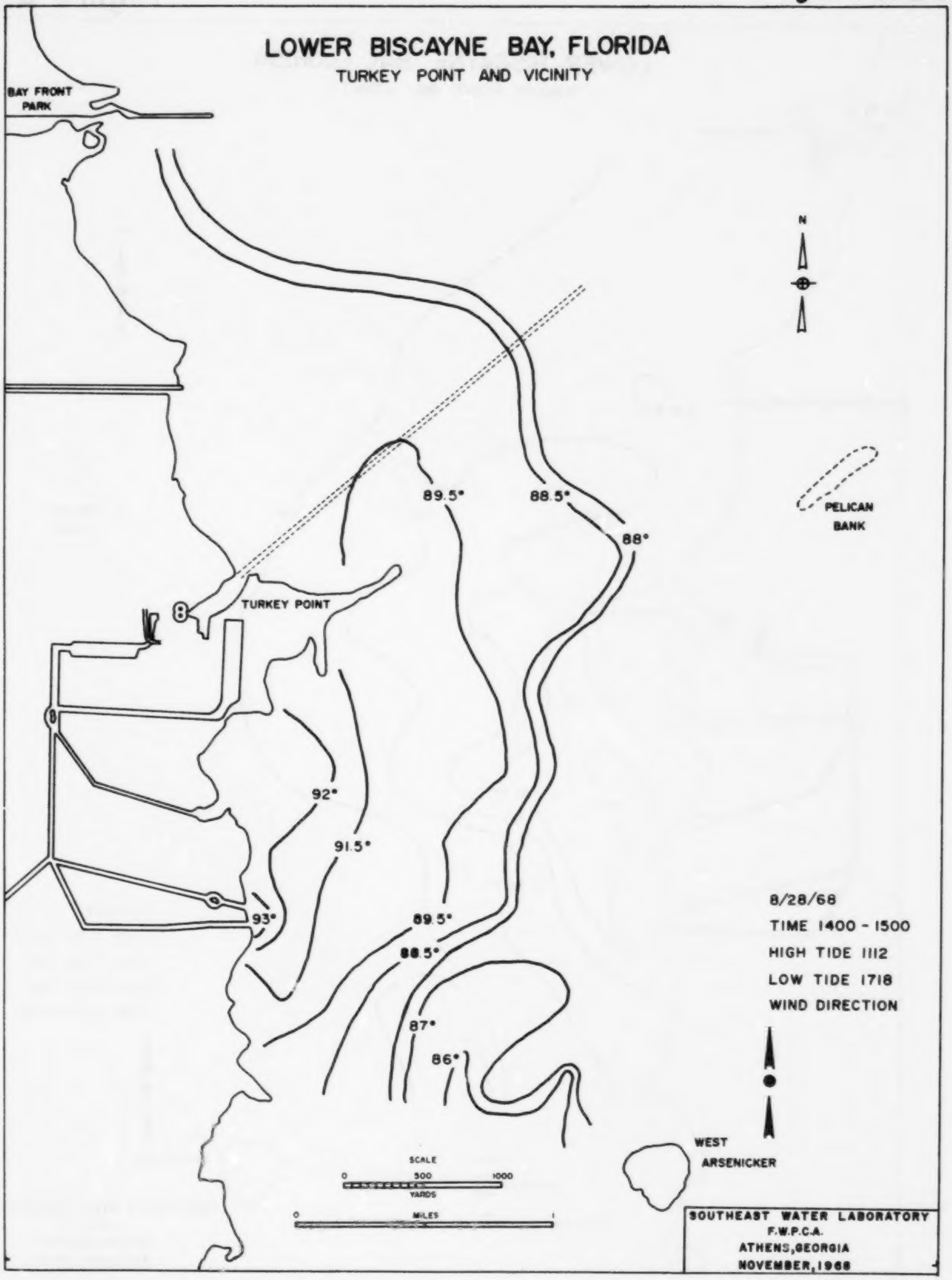

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
PELICAN BANK
TURKEY POINT
89.5°
88.5°
88°
92°
91.5°
93°
89.5°
88.5°
87°
86°
8/28/68
TIME 1400 - 1500
HIGH TIDE 1112
LOW TIDE 1718
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A21

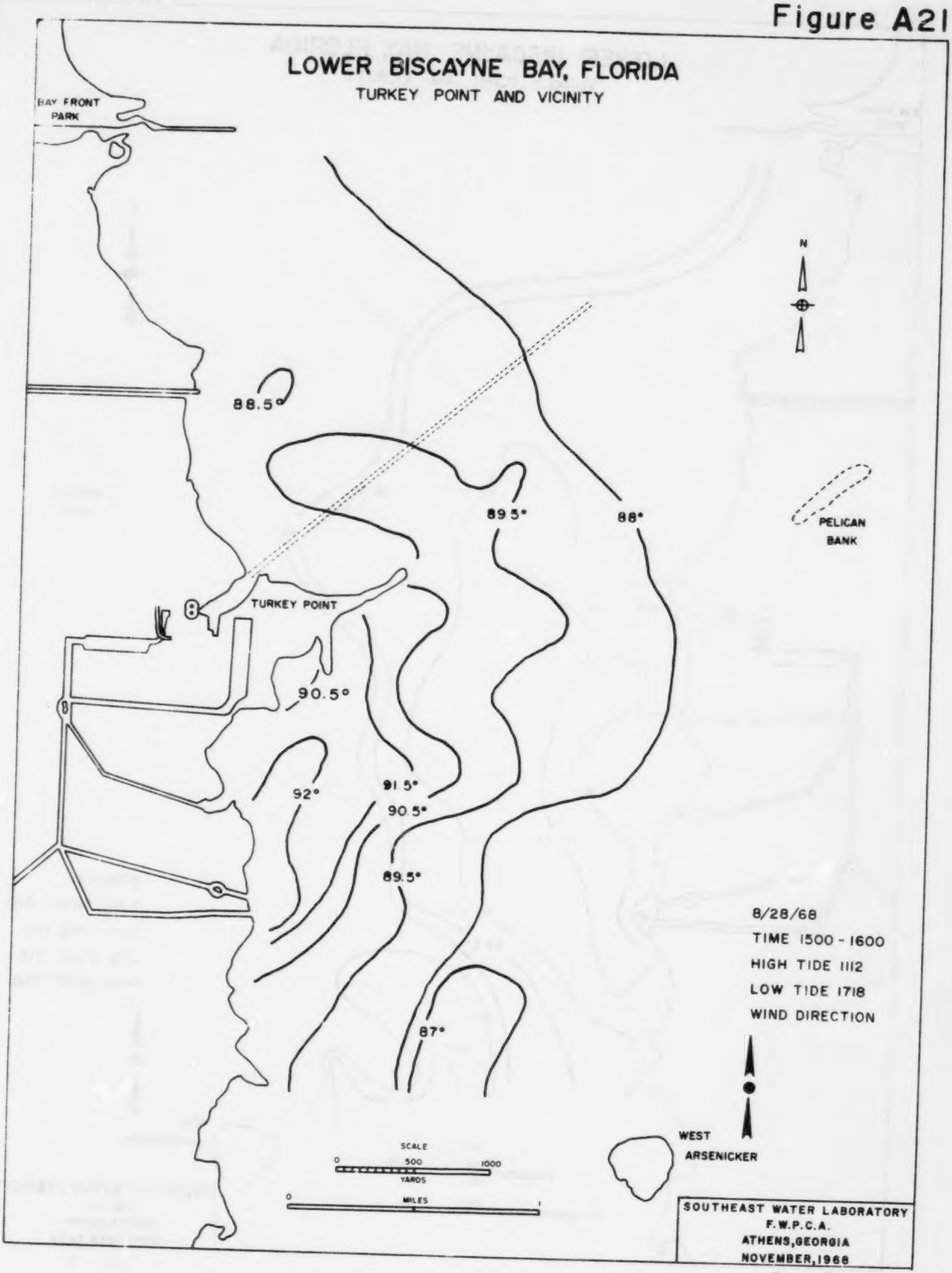

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88.5°
89.5°
88°
PELICAN BANK
TURKEY POINT
90.5°
92°
91.5°
90.5°
89.5°
87°
8/28/68
TIME 1500 - 1600
HIGH TIDE 1112
LOW TIDE 1718
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A22

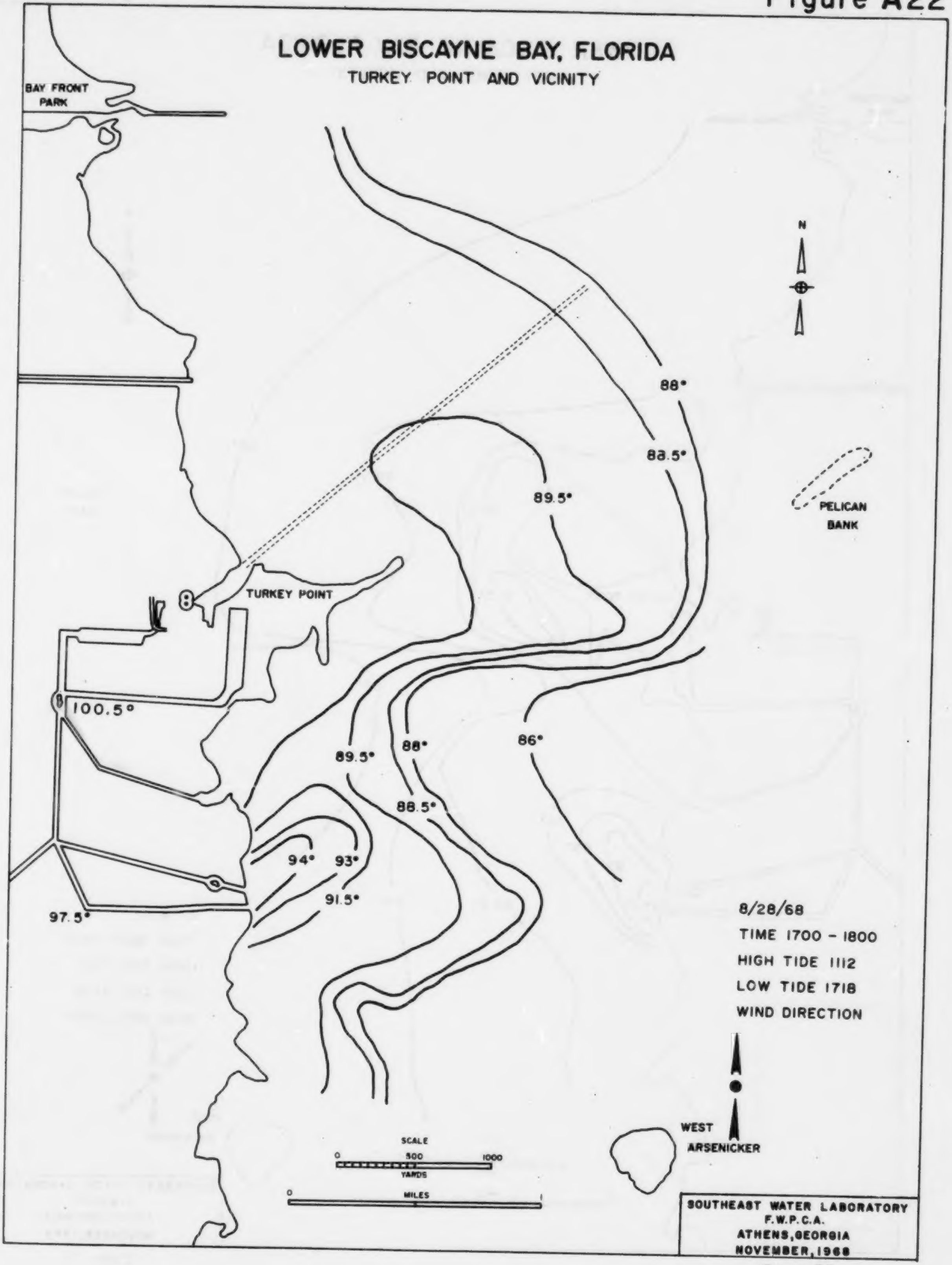
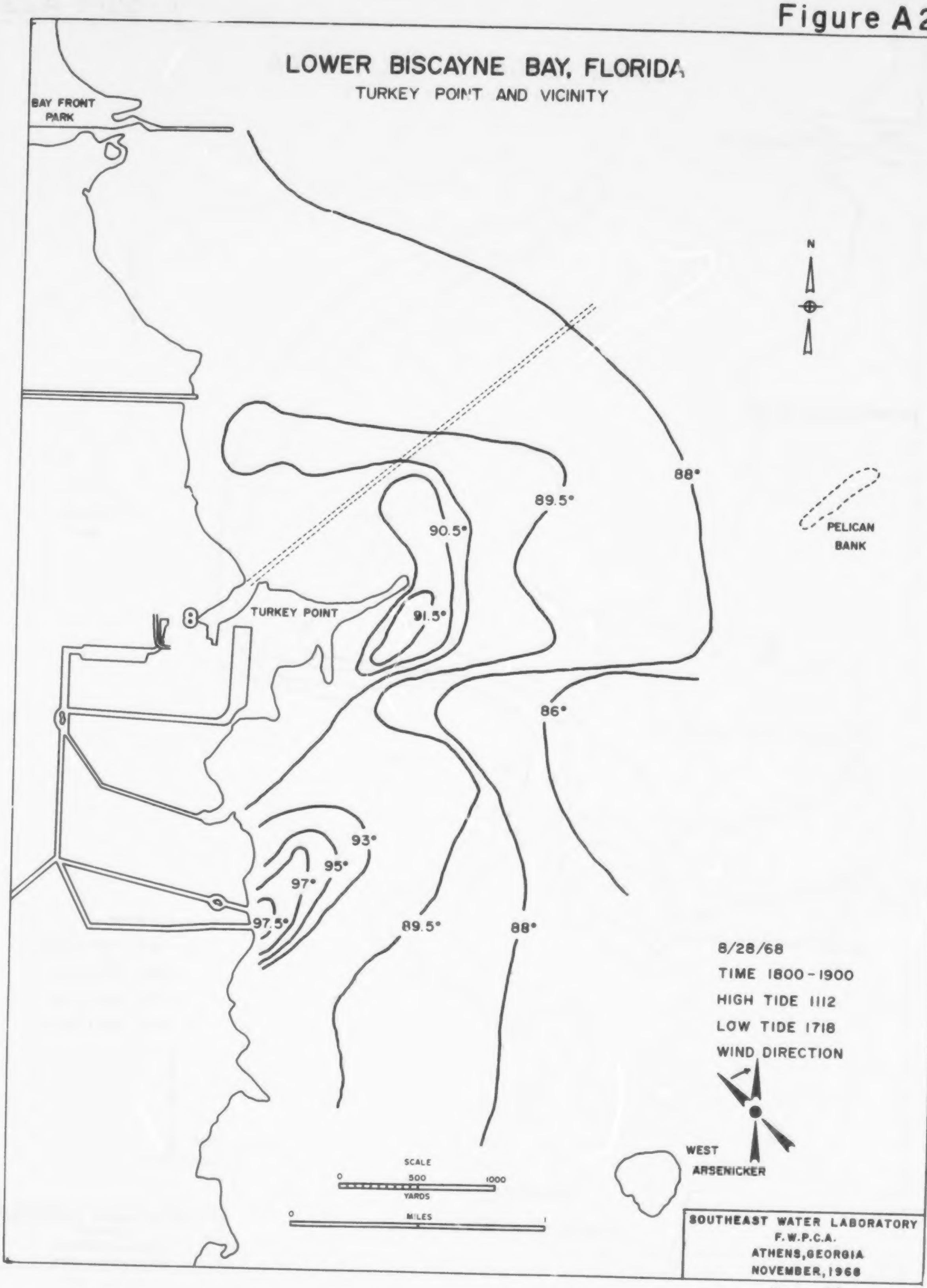

LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
88.5°
89.5°
PELICAN BANK
TURKEY POINT
100.5°
86°
89.5°
88°
88.5°
94°
93°
91.5°
97.5°
8/28/68
TIME 1700 - 1800
HIGH TIDE 1112
LOW TIDE 1718
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

Figure A23


LOWER BISCAYNE BAY, FLORIDA
TURKEY POINT AND VICINITY
BAY FRONT PARK
N
88°
89.5°
90.5°
91.5°
TURKEY POINT
PELICAN BANK
86°
93°
95°
97°
97.5°
89.5°
88°
8/28/68
TIME 1800-1900
HIGH TIDE 1112
LOW TIDE 1718
WIND DIRECTION
WEST ARSENICKER
SCALE
0
500
1000
YARDS
0
MILES
1
SOUTHEAST WATER LABORATORY
F.W.P.C.A.
ATHENS, GEORGIA
NOVEMBER, 1968

APPENDIX B

SUMMARY OF MONITORING DATA

TABLE B-1

MAXIMUM WATER TEMPERATURE, BY TWO WEEK PERIODS, LOWER BISCAYNE BAY FROM APRIL THROUGH AUGUST, 1968

	PERIOD						
STATION	APR 9 - APR 23	MAY 4 - MAY 17	MAY 18 - JUN 1	JUN 2 - JUN 14	JUN 15 - JUN 28	JUL 29 - AUG 12	AUG 13 - AUG 27
A1	82	87				90	91
B4	82	85	86	87	89	90	90
C6		82	85		86	87	88
D8	80	84	87		84	87	
E9	82	82			87	87	87
G12		84	86			90	91
G15		84				90	90
H13	83	88	88		92	92	93
H13A						94	96
H14	81	86	87				93

TABLE B-2

RANGE OF DIFFERENCE BETWEEN MAXIMUM AND MINIMUM DAILY TEMPERATURE AND THE AVERAGE DAILY DIFFERENCE IN LATE JULY AND AUGUST AT ALL MONITOR STATIONS

	PERIOD			
	Jul 29 - AUG 12		AUG 13 - AUG 26	
STATION	RANGE(°F)	AVERAGE DAILY DIFFERENCE(°F)	RANGE(°F)	AVERAGE DAILY DIFFERENCE(°F)
B4	2-6°	3.7°	2-5°	3.4°
C6	2-4°	2.5°	2-4°	2.7°
E9	2-4°	2.2°	1-3°	1.9°
H13	2-8°	4.2°	2-4°	2.6°
H13A	No Data	No Data	2-9°	4.0°
H14	No Data	No Data	3-7°	4.5°
G12	2-5°	3.3°	2-5°	3.5°
A1	2-7°	4.3°	2-6°	3.6°
G15	2-4°	2.8°	1-3°	2.5°

TABLE B-3

HOURLY RATE OF CHANGE (°F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 12, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100						
0100-0200						
0200-0300						
0300-0400						
0400-0500						
0500-0600						
0600-0700						
0700-0800						
0800-0900						
0900-1000						
1000-1100						
1100-1200					1.00	0.00
1200-1300					0.00	0.00
1300-1400				0.00	0.00	0.00
1400-1500	0.00	0.00		0.00	1.00	0.00
1500-1600	0.00	1.00	0.00	1.00	0.00	0.00
1600-1700	0.00	0.00	0.00	0.00	1.00	0.00
1700-1800	0.00	1.00	0.00	0.00	0.00	0.00
1800-1900	1.00	1.00	1.00	0.00	1.00	0.00
1900-2000	0.00	0.00	0.00	0.00	0.00	1.00
2000-2100	0.00	0.00	0.00	1.00	0.00	0.00
2100-2200	0.00	1.00	1.00	0.00	0.00	1.00
2200-2300	0.00	0.00	1.00	0.00	1.00	0.00
2300-2400	0.00	0.00	0.00	0.00	0.00	0.00

TABLE B-4

HOURLY RATE OF CHANGE (°F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 13, 1968

TIME	STATION H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	0.00	0.00	0.00	0.00
0100-0200	0.00	1.00	1.00	0.00	0.00	0.00
0200-0300	0.00	0.00	0.00	0.00	0.00	1.00
0300-0400	0.00	1.00	0.00	0.00	0.00	0.00
0400-0500	1.00	0.00	0.00	0.00	0.00	1.00
0500-0600	0.00	0.00	0.00	1.00	0.00	0.00
0600-0700	0.00	0.00	0.00	0.00	1.00	0.00
0700-0800	0.00	0.00	0.00	0.00	1.00	2.00
0800-0900	0.00	1.00	0.00	0.00	1.00	0.00
0900-1000	0.00	2.00	0.00	1.00	0.00	0.00
1000-1100	0.00	0.00	0.00	1.00	0.00	1.00
1100-1200	0.00	0.00	0.00	0.00	0.00	0.00
1200-1300	1.00	0.00	1.00	0.00	1.00	1.00
1300-1400	1.00	1.00	0.00	0.00	0.00	0.00
1400-1500	0.00	0.00	1.00	0.00	0.00	0.00
1500-1600	0.00	0.00	1.00	0.00	1.00	1.00
1600-1700	0.00	0.00	1.00	0.00	0.00	0.00
1700-1800	0.00	0.00	0.00	0.00	0.00	0.00
1800-1900	0.00	0.00	0.00	0.00	0.00	0.00
1900-2000	0.00	0.00	1.00	0.00	1.00	1.00
2000-2100	0.00	0.00	0.00	1.00	0.00	0.00
2100-2200	0.00	1.00	1.00	0.00	0.00	0.00
2200-2300	0.00	0.00	1.00	0.00	0.00	1.00
2300-2400	0.00	0.00	0.00	0.00	0.00	0.00

TABLE B-5

HOURLY RATE OF CHANGE (^{o}F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 14, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	1.00	1.00	0.00	0.00	0.00	1.00
0100-0200	0.00	0.00	1.00	1.00	0.00	0.00
0200-0300	0.00	1.00	0.00	0.00	0.00	0.00
0300-0400	0.00	0.00	0.00	0.00	0.00	0.00
0400-0500	0.00	0.00	0.00	0.00	0.00	1.00
0500-0600	0.00	0.00	0.00	0.00	0.00	0.00
0600-0700	0.00	1.00	0.00	0.00	0.00	0.00
0700-0800	1.00	1.00	0.00	0.00	0.00	0.00
0800-0900	0.00	1.00	0.00	0.00	0.00	1.00
0900-1000	0.00	0.00	0.00	1.00	0.00	0.00
1000-1100	0.00	1.00	0.00	0.00	0.00	0.00
1100-1200	0.00	1.00	1.00	0.00	1.00	1.00
1200-1300	1.00	2.00	0.00	0.00	0.00	1.00
1300-1400	0.00	1.00	1.00	1.00	0.00	0.00
1400-1500	0.00	0.00	0.00	0.00	1.00	0.00
1500-1600	0.00	0.00	0.00	0.00	0.00	1.00
1600-1700	0.00	0.00	0.00	0.00	1.00	0.00
1700-1800	0.00	1.00	0.00	0.00	0.00	0.00
1800-1900	0.00	1.00	0.00	0.00	1.00	1.00
1900-2000	0.00	0.00	0.00	0.00	0.00	0.00
2000-2100	0.00	0.00	0.00	0.00	0.00	0.00
2100-2200	0.00	0.00	1.00	0.00	0.00	0.00
2200-2300	0.00	0.00	0.00	1.00	0.00	1.00
2300-2400	0.00	0.00	1.00	0.00	0.00	0.00

TABLE B-6

HOURLY RATE OF CHANGE (^{o}F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 15, 1968

	STATION					
TIME	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	1.00	0.00	0.00	1.00	0.00
0100-0200	0.00	0.00	0.00	0.00	0.00	1.00
0200-0300	0.00	1.00	0.00	1.00	0.00	0.00
0300-0400	0.00	0.00	0.00	0.00	1.00	0.00
0400-0500	0.00	1.00	0.00	0.00	0.00	0.00
0500-0600	0.00	0.00	0.00	0.00	0.00	1.00
0600-0700	0.00	1.00	1.00	0.00	1.00	0.00
0700-0800	0.00	0.00	0.00	0.00	0.00	0.00
0800-0900	0.00	0.00	1.00	0.00	0.00	0.00
0900-1000	1.00	0.00	1.00	0.00	0.00	1.00
1000-1100	0.00	2.00	1.00	1.00	0.00	0.00
1100-1200	0.00	1.00	1.00	0.00	0.00	1.00
1200-1300	0.00	1.00	0.00	1.00	0.00	1.00
1300-1400	0.00	1.00	1.00	0.00	0.00	0.00
1400-1500	0.00	0.00	0.00	0.00	1.00	1.00
1500-1600	0.00	0.00	0.00	0.00	0.00	0.00
1600-1700	0.00	0.00	1.00	0.00	0.00	0.00
1700-1800	1.00	0.00	0.00	0.00	0.00	0.00
1800-1900	0.00	1.00	0.00	0.00	1.00	0.00
1900-2000	0.00	0.00	0.00	0.00	0.00	1.00
2000-2100	0.00	0.00	0.00	0.00	0.00	1.00
2100-2200	0.00	1.00	0.00	0.00	0.00	0.00
2200-2300	0.00	0.00	1.00	0.00	0.00	0.00
2300-2400	0.00	0.00	0.00	1.00	0.00	0.00

TABLE B-7

HOURLY RATE OF CHANGE (^{o}F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 16, 1968

TIME	STATION H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	0.00	0.00	0.00	0.00
0100-0200	0.00	1.00	0.00	0.00	1.00	0.00
0200-0300	0.00	0.00	0.00	0.00	0.00	0.00
0300-0400	0.00	1.00	0.00	0.00	0.00	1.00
0400-0500	0.00	0.00	1.00	0.00	0.00	0.00
0500-0600	0.00	0.00	0.00	1.00	0.00	0.00
0600-0700	0.00	1.00	0.00	0.00	0.00	0.00
0700-0800	0.00	0.00	1.00	0.00	0.00	1.00
0800-0900	0.00	1.00	0.00	0.00	0.00	0.00
0900-1000	0.00	1.00	0.00	1.00	0.00	0.00
1000-1100	0.00	0.00	1.00	0.00	0.00	2.00
1100-1200	0.00	1.00	0.00	0.00	0.00	0.00
1200-1300	0.00	0.00	0.00	1.00	1.00	1.00
1300-1400	0.00	1.00	1.00	0.00	0.00	1.00
1400-1500	0.00	0.00	0.00	0.00	0.00	0.00
1500-1600	0.00	0.00	0.00	0.00	0.00	1.00
1600-1700	0.00	0.00	0.00	0.00	0.00	0.00
1700-1800	0.00	0.00	0.00	0.00	0.00	0.00
1800-1900	0.00	0.00	0.00	0.00	2.00	1.00
1900-2000	0.00	0.00	0.00	0.00	1.00	0.00
2000-2100	0.00	0.00	1.00	0.00	0.00	0.00
2100-2200	3.00	1.00	0.00	0.00	0.00	1.00
2200-2300	1.00	0.00	0.00	0.00	0.00	0.00
2300-2400	0.00	1.00	1.00	0.00	0.00	0.00

TABLE B-8

HOURLY RATE OF CHANGE (°F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 17, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	0.00	1.00	0.00	1.00
0100-0200	1.00	1.00	0.00	0.00	1.00	0.00
0200-0300	0.00	0.00	0.00	0.00	0.00	0.00
0300-0400	1.00	1.00	0.00	0.00	0.00	0.00
0400-0500	0.00	0.00	1.00	0.00	1.00	1.00
0500-0600	0.00	0.00	1.00	0.00	0.00	0.00
0600-0700	0.00	0.00	0.00	0.00	0.00	0.00
0700-0800	0.00	0.00	1.00	1.00	1.00	1.00
0800-0900	0.00	3.00	1.00	0.00	0.00	0.00
0900-1000	0.00	1.00	2.00	0.00	0.00	0.00
1000-1100	0.00	1.00	0.00	1.00	1.00	0.00
1100-1200	0.00	0.00	0.00	0.00	0.00	1.00
1200-1300	0.00	1.00	1.00	1.00	0.00	1.00
1300-1400	0.00	1.00	0.00	0.00	0.00	0.00
1400-1500	0.00	1.00	0.00	1.00	0.00	1.00
1500-1600	0.00	1.00	0.00	0.00	1.00	1.00
1600-1700	0.00	0.00	0.00	0.00	0.00	0.00
1700-1800	0.00	0.00	0.00	0.00	0.00	0.00
1800-1900	0.00	1.00	0.00	0.00	1.00	0.00
1900-2000	0.00	0.00	0.00	0.00	0.00	0.00
2000-2100	0.00	1.00	1.00	1.00	0.00	0.00
2100-2200	2.00	1.00	0.00	0.00	0.00	0.00
2200-2300	0.00	0.00	0.00	0.00	0.00	0.00
2300-2400	0.00	1.00	0.00	0.00	0.00	1.00

TABLE B-9

HOURLY RATE OF CHANGE (^{o}F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 18, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	1.00	1.00	0.00	0.00	0.00
0100-0200	0.00	0.00	1.00	0.00	0.00	1.00
0200-0300	0.00	0.00	0.00	0.00	0.00	0.00
0300-0400	1.00	0.00	0.00	0.00	0.00	1.00
0400-0500	0.00	1.00	0.00	1.00	0.00	0.00
0500-0600	1.00	0.00	0.00	0.00	0.00	0.00
0600-0700	1.00	0.00	0.00	0.00	0.00	0.00
0700-0800	1.00	0.00	1.00	0.00	0.00	0.00
0800-0900	0.00	2.00	0.00	0.00	0.00	1.00
0900-1000	0.00	0.00	0.00	0.00	1.00	0.00
1000-1100	1.00	1.00	1.00	0.00	0.00	1.00
1100-1200	1.00	1.00	0.00	1.00	0.00	0.00
1200-1300	0.00	0.00	0.00	0.00	0.00	2.00
1300-1400	1.00	0.00	0.00	0.00	0.00	0.00
1400-1500	0.00	0.00	1.00	0.00	0.00	1.00
1500-1600	0.00	1.00	0.00	0.00	1.00	1.00
1600-1700	0.00	0.00	0.00	1.00	0.00	0.00
1700-1800	0.00	0.00	0.00	0.00	1.00	0.00
1800-1900	0.00	0.00	0.00	0.00	0.00	0.00
1900-2000	0.00	0.00	1.00	0.00	0.00	0.00
2000-2100	1.00	0.00	0.00	1.00	0.00	1.00
2100-2200	0.00	1.00	0.00	0.00	0.00	0.00
2200-2300	0.00	0.00	0.00	0.00	0.00	1.00
2300-2400	0.00	1.00	0.00	0.00	1.00	0.00

TABLE B-10

HOURLY RATE OF CHANGE (°F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 19, 1968

	STATION					
TIME	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	1.00	0.00	0.00	0.00
0100-0200	0.00	0.00	1.00	0.00	0.00	0.00
0200-0300	0.00	0.00	1.00	1.00	0.00	1.00
0300-0400	0.00	0.00	1.00	0.00	0.00	0.00
0400-0500	0.00	0.00	0.00	0.00	0.00	0.00
0500-0600	1.00	0.00	0.00	0.00	0.00	0.00
0600-0700	1.00	0.00	0.00	0.00	0.00	1.00
0700-0800	0.00	0.00	0.00	0.00	0.00	0.00
0800-0900	0.00	1.00	0.00	0.00	0.00	0.00
0900-1000	0.00	0.00	0.00	0.00	0.00	0.00
1000-1100	0.00	1.00	0.00	0.00	1.00	0.00
1100-1200	0.00	0.00	0.00	1.00	0.00	1.00
1200-1300	0.00	1.00	1.00	0.00	1.00	0.00
1300-1400	0.00	1.00	1.00	0.00	0.00	0.00
1400-1500	0.00	2.00	0.00	1.00	0.00	0.00
1500-1600	0.00	2.00	0.00	0.00	0.00	1.00
1600-1700	0.00	0.00	1.00	0.00	0.00	2.00
1700-1800	0.00	1.00	0.00	0.00	0.00	0.00
1800-1900	0.00	1.00	0.00	0.00	0.00	0.00
1900-2000	2.00	2.00	1.00	0.00	0.00	0.00
2000-2100	0.00	0.00	0.00	1.00	1.00	0.00
2100-2200	0.00	2.00	0.00	0.00	0.00	1.00
2200-2300	0.00	0.00	0.00	0.00	1.00	0.00
2300-2400	0.00	0.00	0.00	0.00	0.00	1.00

TABLE B-11

HOURLY RATE OF CHANGE ($^{\circ}$F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 20, 1968

	STATION					
TIME	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	1.00	0.00	0.00	0.00	0.00
0100-0200	0.00	0.00	0.00	0.00	0.00	0.00
0200-0300	0.00	1.00	0.00	0.00	0.00	0.00
0300-0400	0.00	0.00	1.00	0.00	0.00	0.00
0400-0500	0.00	0.00	1.00	1.00	0.00	0.00
0500-0600	0.00	0.00	0.00	0.00	0.00	0.00
0600-0700	0.00	0.00	0.00	0.00	0.00	1.00
0700-0800	1.00	1.00	0.00	0.00	1.00	1.00
0800-0900	1.00	0.00	1.00	0.00	0.00	0.00
0900-1000	0.00	1.00	0.00	0.00	0.00	0.00
1000-1100	0.00	0.00	1.00	0.00	0.00	0.00
1100-1200	0.00	0.00	0.00	1.00	0.00	0.00
1200-1300	0.00	0.00	0.00	0.00	0.00	1.00
1300-1400	0.00	1.00	2.00	1.00	1.00	1.00
1400-1500	0.00	1.00	0.00	0.00	0.00	1.00
1500-1600	0.00	1.00	1.00	0.00	0.00	0.00
1600-1700	0.00	1.00	1.00	0.00	0.00	0.00
1700-1800	0.00	2.00	0.00	0.00	0.00	1.00
1800-1900	0.00	1.00	1.00	0.00	1.00	0.00
1900-2000	0.00	0.00	1.00	0.00	0.00	0.00
2000-2100	1.00	0.00	0.00	0.00	0.00	0.00
2100-2200	0.00	1.00	0.00	1.00	0.00	1.00
2200-2300	0.00	0.00	1.00	0.00	0.00	0.00
2300-2400	0.00	0.00	0.00	0.00	0.00	0.00

TABLE B-12

HOURLY RATE OF CHANGE (^{o}F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 21, 1968

	STATION					
TIME	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	1.00	0.00	0.00	1.00	0.00
0100-0200	0.00	1.00	0.00	0.00	0.00	1.00
0200-0300	1.00	0.00	1.00	0.00	0.00	0.00
0300-0400	0.00	0.00	0.00	0.00	0.00	0.00
0400-0500	0.00	1.00	0.00	0.00	0.00	0.00
0500-0600	0.00	0.00	0.00	0.00	0.00	0.00
0600-0700	0.00	0.00	1.00	0.00	0.00	1.00
0700-0800	0.00	0.00	0.00	0.00	0.00	1.00
0800-0900	0.00	0.00	0.00	0.00	0.00	0.00
0900-1000	0.00	1.00	1.00	1.00	0.00	0.00
1000-1100	0.00	0.00	0.00	1.00	0.00	0.00
1100-1200	0.00	0.00	1.00	0.00	1.00	0.00
1200-1300	0.00	0.00	0.00	0.00	0.00	0.00
1300-1400	0.00	0.00	1.00	0.00	1.00	0.00
1400-1500	1.00	1.00	0.00	0.00	0.00	2.00
1500-1600	1.00	2.00	2.00	0.00	0.00	0.00
1600-1700	0.00	1.00	2.00	1.00	1.00	1.00
1700-1800	0.00	0.00	1.00	0.00	0.00	0.00
1800-1900	0.00	1.00	1.00	0.00	0.00	0.00
1900-2000	0.00	1.00	1.00	0.00	1.00	0.00
2000-2100	1.00	0.00	1.00	0.00	0.00	1.00
2100-2200	0.00	0.00	1.00	0.00	0.00	0.00
2200-2300	0.00	0.00	1.00	0.00	1.00	0.00
2300-2400	0.00	1.00	0.00	0.00	0.00	1.00

TABLE B-13

HOURLY RATE OF CHANGE (°F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 22, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	1.00	0.00	1.00	0.00	0.00
0100-0200	1.00	0.00	0.00	0.00	0.00	1.00
0200-0300	0.00	0.00	0.00	0.00	0.00	0.00
0300-0400	0.00	1.00	0.00	0.00	0.00	0.00
0400-0500	0.00	0.00	1.00	0.00	1.00	1.00
0500-0600	0.00	0.00	0.00	0.00	0.00	0.00
0600-0700	0.00	0.00	1.00	0.00	0.00	0.00
0700-0800	0.00	0.00	1.00	0.00	0.00	0.00
0800-0900	0.00	1.00	2.00	0.00	0.00	0.00
0900-1000	0.00	0.00	2.00	0.00	0.00	0.00
1000-1100	0.00	0.00	0.00	0.00	1.00	1.00
1100-1200	0.00	0.00	0.00	0.00	0.00	1.00
1200-1300	0.00	0.00	0.00	0.00	0.00	0.00
1300-1400	0.00	0.00	0.00	0.00	0.00	0.00
1400-1500	0.00	0.00	0.00	0.00	0.00	0.00
1500-1600	0.00	1.00	2.00	0.00	0.00	0.00
1600-1700	0.00	0.00	2.00	1.00	0.00	0.00
1700-1800	0.00	1.00	1.00	0.00	0.00	0.00
1800-1900	0.00	1.00	0.00	0.00	1.00	0.00
1900-2000	0.00	0.00	0.00	0.00	1.00	0.00
2000-2100	0.00	0.00	0.00	0.00	1.00	0.00
2100-2200	0.00	1.00	1.00	0.00	0.00	1.00
2200-2300	0.00	1.00	1.00	0.00	0.00	0.00
2300-2400	0.00	0.00	0.00	0.00	0.00	0.00

TABLE B-14

HOURLY RATE OF CHANGE (^oF) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 23, 1968

	STATION					
TIME	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	2.00	0.00	0.00	1.00
0100-0200	0.00	1.00	1.00	1.00	0.00	0.00
0200-0300	0.00	0.00	0.00	0.00	2.00	0.00
0300-0400	0.00	0.00	0.00	0.00	0.00	0.00
0400-0500	0.00	1.00	1.00	0.00	0.00	0.00
0500-0600	0.00	1.00	0.00	0.00	0.00	1.00
0600-0700	0.00	1.00	0.00	0.00	0.00	0.00
0700-0800	0.00	1.00	1.00	0.00	0.00	0.00
0800-0900	1.00	0.00	0.00	0.00	0.00	0.00
0900-1000	0.00	1.00	0.00	0.00	0.00	0.00
1000-1100	0.00	2.00	1.00	0.00	0.00	1.00
1100-1200	0.00	0.00	0.00	0.00	0.00	0.00
1200-1300	0.00	0.00	1.00	1.00	0.00	1.00
1300-1400	1.00	0.00	1.00	0.00	0.00	0.00
1400-1500	0.00	0.00	0.00	1.00	0.00	0.00
1500-1600	0.00	0.00	1.00	0.00	1.00	0.00
1600-1700	0.00	0.00	1.00	0.00	0.00	1.00
1700-1800	0.00	0.00	1.00	0.00	1.00	0.00
1800-1900	0.00	1.00	1.00	0.00	0.00	0.00
1900-2000	0.00	0.00	1.00	0.00	0.00	1.00
2000-2100	0.00	1.00	0.00	0.00	1.00	0.00
2100-2200	0.00	0.00	0.00	0.00	0.00	0.00
2200-2300	0.00	0.00	1.00	0.00	0.00	0.00
2300-2400	0.00	0.00	1.00	0.00	0.00	1.00

TABLE B-15

HOURLY RATE OF CHANGE (^{o}F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 24, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	1.00	0.00	0.00	0.00
0100-0200	0.00	1.00	1.00	0.00	0.00	0.00
0200-0300	0.00	1.00	0.00	0.00	1.00	0.00
0300-0400	0.00	0.00	0.00	0.00	0.00	0.00
0400-0500	0.00	1.00	0.00	0.00	0.00	0.00
0500-0600	0.00	0.00	0.00	0.00	0.00	1.00
0600-0700	0.00	1.00	0.00	0.00	0.00	0.00
0700-0800	0.00	0.00	0.00	1.00	0.00	0.00
0800-0900	0.00	0.00	0.00	0.00	0.00	0.00
0900-1000	0.00	1.00	0.00	0.00	0.00	1.00
1000-1100	0.00	0.00	0.00	0.00	0.00	0.00
1100-1200	0.00	1.00	1.00	0.00	1.00	0.00
1200-1300	0.00	0.00	0.00	0.00	0.00	0.00
1300-1400	1.00	1.00	0.00	0.00	0.00	1.00
1400-1500	1.00	0.00	0.00	1.00	0.00	0.00
1500-1600	1.00	0.00	0.00	0.00	0.00	0.00
1600-1700	0.00	0.00	1.00	0.00	0.00	0.00
1700-1800	0.00	1.00	0.00	0.00	0.00	0.00
1800-1900	1.00	0.00	1.00	0.00	0.00	0.00
1900-2000	0.00	0.00	1.00	0.00	0.00	0.00
2000-2100	0.00	0.00	0.00	0.00	1.00	0.00
2100-2200	0.00	0.00	0.00	0.00	0.00	0.00
2200-2300	0.00	1.00	1.00	0.00	0.00	0.00
2300-2400	0.00	0.00	0.00	0.00	1.00	0.00

TABLE B-16

HOURLY RATE OF CHANGE (°F) AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 25, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	1.00	0.00	0.00	1.00
0100-0200	0.00	0.00	0.00	0.00	0.00	0.00
0200-0300	0.00	0.00	1.00	1.00	1.00	0.00
0300-0400	0.00	0.00	0.00	0.00	0.00	0.00
0400-0500	0.00	1.00	0.00	0.00	0.00	0.00
0500-0600	0.00	0.00	0.00	0.00	0.00	0.00
0600-0700	0.00	1.00	0.00	0.00	0.00	0.00
0700-0800	0.00	1.00	0.00	0.00	0.00	1.00
0800-0900	0.00	0.00	0.00	0.00	0.00	0.00
0900-1000	0.00	0.00	0.00	0.00	1.00	0.00
1000-1100	0.00	0.00	0.00	0.00	0.00	1.00
1100-1200	0.00	0.00	1.00	0.00	0.00	0.00
1200-1300	0.00	0.00	0.00	0.00	0.00	0.00
1300-1400	0.00	0.00	0.00	0.00	0.00	0.00
1400-1500	1.00	0.00	0.00	1.00	1.00	0.00
1500-1600	0.00	0.00	0.00	0.00	0.00	0.00
1600-1700	0.00	0.00	1.00	0.00	0.00	0.00
1700-1800	0.00	1.00	0.00	1.00	0.00	0.00
1800-1900	0.00	0.00	1.00	0.00	0.00	0.00
1900-2000	1.00	0.00	1.00	0.00	0.00	0.00
2000-2100	0.00	0.00	1.00	0.00	0.00	0.00
2100-2200	1.00	0.00	0.00	0.00	0.00	0.00
2200-2300	0.00	0.00	1.00	0.00	0.00	0.00
2300-2400	0.00	0.00	0.00	0.00	1.00	0.00

TABLE B-17

HOURLY RATE OF CHANGE (^{o}F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 26, 1968

TIME	STATION					
	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	1.00	0.00	0.00	0.00
0100-0200	0.00	0.00	1.00	0.00	0.00	0.00
0200-0300	1.00	0.00	0.00	0.00	1.00	0.00
0300-0400	0.00	0.00	0.00	1.00	0.00	0.00
0400-0500	0.00	0.00	1.00	0.00	0.00	0.00
0500-0600	0.00	0.00	0.00	0.00	0.00	0.00
0600-0700	0.00	1.00	0.00	0.00	0.00	0.00
0700-0800	0.00	0.00	0.00	0.00	0.00	1.00
0800-0900	0.00	1.00	0.00	0.00	0.00	0.00
0900-1000	1.00	0.00	1.00	0.00	0.00	0.00
1000-1100	0.00	0.00	1.00	0.00	0.00	1.00
1100-1200	1.00	0.00	0.00	0.00	0.00	0.00
1200-1300	0.00	0.00	0.00	1.00	0.00	0.00
1300-1400	0.00	1.00	0.00	0.00	1.00	0.00
1400-1500	0.00	0.00	0.00	0.00	0.00	0.00
1500-1600	0.00	1.00	0.00	0.00	0.00	0.00
1600-1700	0.00	1.00	1.00	0.00	1.00	0.00
1700-1800	0.00	0.00	0.00	0.00	0.00	0.00
1800-1900	0.00	1.00	0.00	0.00		0.00
1900-2000	0.00	0.00	0.00	0.00		0.00
2000-2100	0.00	0.00	0.00	0.00		0.00
2100-2200	0.00	0.00	1.00	0.00		0.00
2200-2300	0.00	0.00	1.00	0.00		1.00
2300-2400	0.00	1.00	1.00	0.00		0.00

TABLE B-18

HOURLY RATE OF CHANGE (^oF)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 27, 1968

	STATION					
TIME	H13	H13A	H14	E9	C6	B4
2400-0100	0.00	0.00	0.00	0.00		0.00
0100-0200	1.00	1.00	0.00	0.00		0.00
0200-0300	0.00	1.00	0.00	1.00		0.00
0300-0400	0.00	0.00	0.00	0.00		0.00
0400-0500	0.00	1.00	1.00	0.00		
0500-0600	0.00	0.00	1.00	0.00		
0600-0700		0.00	1.00	0.00		
0700-0800		1.00	1.00	0.00		
0800-0900		0.00	0.00	0.00		
0900-1000		0.00	0.00	0.00		
1000-1100		0.00	1.00	0.00		
1100-1200		0.00	0.00	0.00		
1200-1300		1.00	0.00	0.00		
1300-1400		1.00	0.00	1.00		
1400-1500		0.00	0.00	0.00		
1500-1600		0.00	0.00	0.00		
1600-1700		0.00	0.00	0.00		
1700-1800		1.00	0.00	0.00		
1800-1900		1.00	1.00	0.00		
1900-2000		0.00	0.00			
2000-2100		0.00	1.00			
2100-2200		0.00	0.00			
2200-2300			0.00			
2300-2400			0.00			

TABLE B-19

HOURLY RATE OF CHANGE (^{o}F)
AT SELECTED MONITORING STATIONS IN LOWER BISCAYNE BAY ON AUGUST 28, 1968

TIME	STATION H13	H13A	H14	E9	C6	B4
2400-0100			0.00			
0100-0200			0.00			
0200-0300			0.00			
0300-0400			0.00			
0400-0500			0.00			
0500-0600			0.00			
0600-0700			0.00			
0700-0800			1.00			
0800-0900			1.00			
0900-1000			0.00			
1000-1100			0.00			
1100-1200			0.00			
1200-1300			0.00			
1300-1400			0.00			
1400-1500						
1500-1600						
1600-1700						
1700-1800						
1800-1900						
1900-2000						
2000-2100						
2100-2200						
2200-2300						
2300-2400						

DATE	STATION A1			STATION B4			STATION D8			STATION E9			STATION F11			STATION G15		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
04-10-68	81	76	78.4	80	75	77.1	79	76	77.2	80	78	78.6	80	77	79.2	79	76	77.4
04-11-68	82	78	79.2	80	76	76.9	79	76	77.4	80	77	77.9	80	76	79.2	79	77	76.9
04-12-68	75	74	74.7	76	71	72.4	77	71	73.2	78	74	74.4	77	74	74.4	76	74	73.6
04-13-68	74	71	72.6	72	69	70.4	74	71	72.4	75	73	73.9	74	72	73.2	73	71	72.5
04-14-68	76	71	73.1	74	70	71.6	74	71	72.7	75	74	74.4	75	72	73.7	74	71	72.5
04-15-68	76	73	74.0	74	71	72.4	74	72	73.1	75	74	74.4	76	73	74.4	74	71	72.7
04-16-68	76	73	74.4	76	71	72.9	76	72	73.2	76	74	75.1	77	73	75.0	74	71	73.1
04-17-68	77	74	75.2	76	72	73.9	77	71	74.1	77	74	76.2	78	74	76.0	76	73	73.9
04-18-68	79	75	76.7	78	74	75.6	77	74	75.4	78	76	77.0	80	75	77.7	76	74	75.5
04-19-68	81	77	79.2	80	76	77.6	79	75	77.1	80	77	78.4	81	78	79.2	78	75	77.5
04-20-68	82	79	80.2	81	77	78.7	80	76	77.9	80	77	79.4	82	79	79.9	80	77	78.4
04-21-68	82	79	80.7	82	77	79.4	80	76	77.7	81	78	79.6	82	79	80.2	80	78	79.0
04-22-68	82	79	80.7	82	78	79.5	80	76	78.2	81	79	80.1	82	79	80.6	81	78	79.1
04-23-68	83	80	82.0													80	79	79.5

TABLE B-20

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN APRIL 10 AND APRIL 23, 1968

DATE	STATION H13 MAX	STATION H13 MIN	STATION H13 MEAN	STATION H14 MAX	STATION H14 MIN	STATION H14 MEAN
04-10-68	79	74	76.4	79	75	76.5
04-11-68	79	76	77.1	79	76	77.6
04-12-68	74	72	73.1	74	72	73.6
04-13-68	73	69	70.9	73	70	71.2
04-14-68	74	69	71.7	74	70	71.4
04-15-68	74	71	72.2	74	71	72.2
04-16-68	75	71	72.6	74	72	72.7
04-17-68	76	71	73.1	76	72	73.7
04-18-68	78	73	75.5	78	74	75.2
04-19-68	79	76	77.9	79	76	77.2
04-20-68	81	77	79.1	80	78	78.9
04-21-68	82	78	79.7	80	78	79.4
04-22-68	82	78	79.1	80	77	79.1
04-23-68				80	79	80.0

TABLE B-20 (Contd)

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN APRIL 10 AND APRIL 23, 1968

DATE	STATION B4			STATION D8			STATION E9			STATION H13			STATION H14		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
04-24-68	82	78	80.2	82	78	80.0	82	80	80.6	82	78	80.1	82	79	80.2
04-25-68	82	80	80.2	81	78	80.1	82	80	81.3	83	79	80.6	83	79	81.0

TABLE B-21

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES ($^{\circ}$F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN APRIL 24 AND APRIL 25, 1968

DATE	STATION A1			STATION B4			STATION C6			STATION D8			STATION E9			STATION G12		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
05-04-68	82	78	80.0	80	76	77.7	80	78	79.0	82	79	80.6	80	78	78.6	82	77	79.2
05-05-68	82	78	79.4	80	76	78.1	80	76	77.7	82	80	80.2	80	78	78.5	80	77	78.7
05-06-68	80	78	78.9	79	75	76.5	79	77	77.7	81	78	79.5	79	77	77.7	80	76	77.5
05-07-68	80	78	78.1	78	76	77.0	78	76	77.5	80	79	79.4	78	77	77.5	78	76	77.0
05-08-68	78	75	75.9	76	73	74.1	76	75	75.9	78	77	77.6	77	76	76.1	75	74	74.7
05-09-68	76	74	75.0	74	71	73.1	75	74	74.2	77	76	76.2	75	74	74.6	74	73	73.9
05-10-68	76	74	74.7	74	72	72.7	74	73	73.5	76	75	75.6	75	74	74.2	75	73	73.7
05-11-68	76	75	75.5	74	73	73.0	74	73	73.5	77	76	76.4	76	74	74.4	76	74	74.6
05-12-68	80	76	77.4	78	73	74.5	78	74	75.5	80	77	77.9	78	75	75.7	79	75	76.2
05-13-68	81	78	79.7	81	76	77.9	81	77	78.0	81	78	79.5	79	77	77.9	81	77	78.9
05-14-68	84	79	81.4	85	76	79.1	82	78	79.4	82	80	80.4	80	78	78.9	82	78	79.4
05-15-68	86	80	82.3	84	77	80.1	82	78	80.2	83	81	81.5	81	79	79.6	83	79	81.0
05-16-68	84	82	83.2	84	78	81.6	82	80	81.0	84	81	82.1	82	80	80.5	84	81	82.4
05-17-68	85	82	84.5															
05-18-68	86	81	84.5															
05-19-68	86	83	84.0															

TABLE B-22

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (°F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN MAY 4 AND MAY 19, 1968

DATE	STATION G15			STATION H13			STATION H14		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
05-04-68	82	79	80.0	84	80	82.6	82	79	80.7
05-05-68	81	79	80.0	84	79	81.0	82	78	79.1
05-06-68	80	78	78.7	82	78	80.0	81	77	79.1
05-07-68	80	78	78.7	82	80	80.7	80	79	79.0
05-08-68	79	75	76.4	82	78	78.7	79	76	76.9
05-09-68	76	75	75.5	78	75	75.5	77	75	76.0
05-10-68	76	74	75.1	76	74	74.7	76	74	75.1
05-11-68	76	75	75.5	76	74	75.1	76	75	75.5
05-12-68	80	76	76.6	80	75	77.2	80	75	77.4
05-13-68	81	78	79.1	84	78	80.2	82	78	80.0
05-14-68	82	79	80.1	88	79	81.9	84	79	80.9
05-15-68	84	80	81.9	86	71	84.0	85	81	83.7
05-16-68	84	81	83.0	87	83	84.9	85	82	83.4

TABLE 22 (Contd)

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{O}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN MAY 4 AND MAY 19, 1968

DATE	STATION B4			STATION C6			STATION D8			STATION G12			STATION H13			STATION H14		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
05-18-68	85	81	83.2	83	80	82.0	86	82	84.1	86	81	83.2	87	82	84.6	86	82	84.6
05-19-68	86	81	84.0	84	81	82.6	86	83	85.2	86	81	83.9	87	82	84.7	87	83	85.2
05-20-68	84	82	83.2	84	82	83.1	86	84	85.6	85	83	84.2	86	84	84.7	86	84	85.5
05-21-68	86	81	83.6	84	82	82.9	87	84	85.5	86	83	84.2	87	84	85.0	87	84	85.5
05-22-68	86	82	84.1	85	82	83.5	87	84	85.5	87	84	84.7	88	83	85.2	88	84	85.6
05-23-68	84	80	82.4	83	82	82.5	87	84	84.5	85	82	83.9	86	82	84.4	86	83	84.2
05-24-68	82	79	80.2	82	80	80.7	86	83	83.5	83	80	81.9	84	81	82.7	84	82	83.4
05-25-68	81	79	79.9	81	80	80.2	84	82	83.0	83	81	81.7	84	81	83.1	84	82	82.6
05-26-68	80	79	79.5	80	79	79.2	83	81	82.1	83	81	82.0	83	81	81.9	83	82	82.5
05-27-68	82	77	79.0	80	78	79.2	83	81	82.1	83	80	81.3	84	81	82.6	85	80	82.3
05-28-68	82	80	80.2	80	80	80.0	82	81	81.9	82	80	81.6	86	83	84.2	84	82	83.5
05-29-68	82	78	79.4	80	78	79.2	82	81	81.6	82	80	80.5	84	81	82.6	84	81	82.5
05-30-68	82	80	80.6	80	79	79.0	83	81	81.7	82	80	80.9	88	82	85.0	85	82	83.1
05-31-68				80	78	78.6				82	80	81.0	86	82	84.4	86	82	82.6
06-01-68				79	77	77.3				80	79	80.0	86	82	83.4	83	81	81.7
06-02-68										80	76	78.0	83	78	81.4	82	78	80.0

TABLE B-23

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (°F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN MAY 18 AND JUNE 2, 1968

DATE	STATION B4			STATION D8		
	MAX	MIN	MEAN	MAX	MIN	MEAN
06-01-68	79	77	78.7	82	79	80.4
06-02-68	78	75	76.9	81	78	79.6
06-03-68	76	74	74.5	80	77	78.1
06-04-68	79	73	76.7	81	76	78.5
06-05-68	81	75	78.0	83	77	79.7
06-06-68	83	76	79.5	84	79	81.1
06-07-68	85	80	81.9	84	82	82.6
06-08-68	87	82	83.9	86	83	84.2
06-09-68	86	82	83.7	86	83	84.5
06-10-68	83	78	80.9	84	82	83.6
06-11-68	84	80	81.4	86	83	84.5
06-12-68	84	78	80.1	84	82	83.6
06-13-68	86	80	82.1	86	82	84.0

TABLE B-24

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURE (°F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN JUNE 1 AND JUNE 13, 1968

DATE	STATION B4			STATION C6			STATION D8			STATION H13			STATION H13A		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
06-15-68	86	80	82.4	84	80	81.5	82	80	80.9	90	85	88.1	86	82	83.7
06-16-68	81	77	78.9	81	79	79.9	80	78	79.7	86	80	82.7	83	80	81.9
06-17-68	79	76	77.6	80	77	78.1	79	77	78.1	84	81	81.7	82	80	80.6
06-18-68	79	76	77.9	79	76	77.7	78	76	77.5	83	80	81.5			
06-19-68	82	77	79.1	80	77	78.5	80	76	78.0	84	80	81.4			
06-20-68	82	79	80.7	80	78	79.2	80	78	78.6	87	82	84.1			
06-21-68	87	80	83.0	85	79	80.7	83	78	79.7	91	85	87.6			
06-22-68	89	83	86.4	85	82	83.2	84	81	82.1	94	86	89.6			
06-23-68	89	84	86.1	86	82	84.0	84	82	82.9	93	86	90.1			
06-24-68	89	83	85.6	86	83	84.5	84	82	83.4	92	86	89.4			
06-25-68	88	84	85.7	86	83	84.5	84	82	83.5	92	86	88.2			
06-26-68	87	82	83.4	85	82	83.4	84	82	82.6	90	84	86.6			
06-27-68	83	79	79.9	82	79	80.4	82	79	80.4	86	81	83.6			
06-28-68	80	78	79.6	80	77	79.1	80	78	79.0	85	82	83.5			
06-29-68	81	78	80.1	82	76	78.9	82	78	79.1	88	82	84.1			
06-30-68	84	80	81.7				82	79	80.0	88	84	86.0			

TABLE B-25

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN JUNE 15 AND JUNE 30, 1968

DATE	STATION B4			STATION H13A		
	MAX	MIN	MEAN	MAX	MIN	MEAN
07-03-68	83	77	80.6	89	82	85.9
07-04-68	84	79	81.9	89	84	86.5
07-05-68	84	81	82.3	89	84	86.5
07-06-68	82	80	81.5			
07-07-68	81	78	79.9			
07-08-68	82	78	79.9			
07-09-68	86	80	82.1			
07-10-68	86	81	83.5			
07-11-68	86	82	84.5			
07-12-68	88	82	84.7			
07-13-68	87	82	84.9			
07-14-68	86	80	83.4			
07-15-68	84	80	81.9			
07-16-68	86	80	82.4			
07-17-68	86	80	83.5			

TABLE B-26

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN JULY 3 AND JULY 17, 1968

DATE	STATION A1			STATION B4			STATION C6			STATION D8			STATION E9			STATION G12		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
07-28-68	90	75	86.7	89	83	87.1	88	83	85.0	86	85	85.2	86	84	85.2	90	86	87.6
07-29-68	88	84	86.6	90	85	87.4	88	84	85.7	87	85	86.1	87	85	85.9	90	87	88.2
07-30-68	90	86	87.6	89	86	87.2	87	85	86.0	87	84	86.2	86	84	86.0	89	86	88.0
07-31-68	87	84	85.5	38	84	86.1	87	84	85.1	87	84	85.6	86	84	85.5	89	85	87.1
08-01-68	88	83	85.6	89	83	86.2	86	83	84.6	86	84	85.5	86	84	85.0	89	85	86.7
08-02-68	88	84	85.9	88	85	86.1	86	84	84.6	86	84	85.1	86	84	84.7	88	84	86.5
08-03-68	86	83	84.9	86	83	84.5	85	83	83.9				84	82	83.9	86	82	84.9
08-04-68	86	81	82.5	84	81	82.9	84	81	81.5				83	82	82.5	84	82	83.0
08-05-68	89	82	84.2	87	82	84.1	84	81	81.9				84	82	82.6	87	83	84.4
08-06-68	89	83	84.6	87	83	84.9	84	82	83.0				84	82	83.2	88	84	85.7
08-07-68	88	84	85.2	38	84	85.7	86	83	83.6				86	83	84.1	88	84	85.7
08-08-68	88	85	86.1	88	84	86.1	86	83	84.1				86	83	84.6	87	84	86.0
08-09-68	90	84	85.7	87	84	85.6	86	83	84.5				85	82	83.7	86	82	85.5
08-10-68	86	82	83.6	86	82	83.9	85	81	82.7				84	82	82.9	85	82	83.6
08-11-68	86	82	84.4	86	82	83.9	84	82	83.0				84	82	83.0	86	84	84.7
08-12-68	87	83	84.6															

TABLE B-27

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN JULY 28 AND AUGUST 12, 1968

DATE	STATION G15 MAX	STATION G15 MIN	STATION G15 MEAN	STATION H13 MAX	STATION H13 MIN	STATION H13 MEAN	STATION H14 MAX	STATION H14 MIN	STATION H14 MEAN
07-28-68	89	86	87.6	92	87	88.7	90	85	87.4
07-29-68	90	87	87.7	91	89	89.5	89	86	87.2
07-30-68	89	86	88.2	90	86	89.6			
07-31-68	88	85	87.2	91	86	88.5			
08-01-68	88	86	86.9	91	86	89.0			
08-02-68	88	85	86.5	91	86	88.7			
08-03-68	86	83	86.2	89	84	88.2			
08-04-68	85	84	84.1	86	82	85.9			
08-05-68	87	84	84.7	90	84	84.5			
08-06-68	87	84	85.0	89	85	87.6			
08-07-68	88	85	85.9	88	85	87.0			
08-08-68	88	85	86.6	88	85	86.9			
08-09-68	87	83	86.6	89	84	86.6			
08-10-68	86	83	85.1	87	84	86.5			
08-11-68	86	82	84.4						

TABLE B-27 (Contd)

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN JULY 28 AND AUGUST 12, 1968

DATE	STATION A1 MAX	 MIN	 MEAN	STATION B4 MAX	 MIN	 MEAN	STATION C6 MAX	 MIN	 MEAN	STATION E9 MAX	 MIN	 MEAN	STATION G12 MAX	 MIN	 MEAN	STATION G15 MAX	 MIN	 MEAN
08-12-68	89	84	86.2	89	84	86.9	86	84	84.4									
08-13-68	88	85	86.5	89	84	87.0	86	83	84.7	86	84	85.1	89	87	88.2	88	86	86.7
08-14-68	87	84	85.7	89	85	86.9	86	84	85.0	87	84	85.1	89	86	87.6	88	86	87.0
08-15-68	89	84	86.6	89	85	86.9	87	84	85.2	87	84	85.0	90	86	87.2	89	86	87.1
08-16-68	91	85	87.5	89	85	87.4	88	84	85.5	87	84	85.1	90	86	87.5	89	86	87.4
08-17-68	89	85	86.9	90	85	87.4	87	84	86.0	87	84	85.7	91	86	87.9	90	86	87.6
08-18-68	90	85	87.4	90	86	87.7	88	85	86.5	87	85	85.9	90	86	88.1	89	87	87.7
08-19-68	91	85	87.2	90	86	87.5	87	85	86.2	87	84	85.7	90	85	87.1	89	86	87.5
08-20-68	91	85	87.1	90	86	88.0	88	85	86.1	87	84	86.0	90	86	87.7	90	86	88.1
08-21-68	91	85	87.1	90	86	88.0	88	85	86.2	88	85	86.2	90	86	87.9	90	87	88.1
08-22-68	89	85	86.4	90	86	87.2	88	85	86.1	87	85	86.2	90	87	88.5	90	87	88.2
08-23-68	89	85	86.2	89	86	86.4	87	85	85.5	87	85	86.0	89	86	87.7	89	87	87.9
08-24-68	88	85	85.9	88	85	86.0	86	84	84.4	87	85	85.6	88	85	86.9	88	86	87.1
08-25-68	88	85	85.9	88	85	84.6				86	84	85.2	87	85	86.5	88	86	86.7
08-26-68	87	84	85.6	86	84	84.6				85	84	84.7	87	85	86.1	87	85	86.1
08-27-68										86	84	84.7	87	86	86.4	87	85	86.1

TABLE B-28

DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{o}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN AUGUST 12 AND AUGUST 27, 1968

DATE	STATION H13			STATION H13A			STATION H14		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
08-12-68	89	87	88.0	92	88	90.0			
08-13-68	89	87	87.6	93	87	90.5	89	86	87.1
08-14-68	89	87	88.0	93	87	89.9	88	85	86.7
08-15-68	91	88	89.2	92	87	89.6	89	85	86.9
08-16-68	91	89	90.4	96	87	91.0	88	85	86.6
08-17-68	91	88	88.5	93	88	90.4	90	85	88.0
08-18-68	90	88	89.0	97	89	90.7	89	86	87.9
08-19-68	90	88	86.6	95	89	91.2	88	85	87.0
08-20-68	93	89	91.6	93	89	90.7	90	85	87.5
08-21-68	93	89	92.0	93	89	90.2	93	86	88.2
08-22-68	93	90	90.5	93	89	90.6	93	86	88.5
08-23-68	90	87	88.0	92	90	90.1	93	86	88.6
08-24-68	89	87	87.9	90	87	89.0	91	86	87.5
08-25-68	89	86	86.6				89	85	86.5
08-26-68							89	85	86.1
08-27-68							89	85	86.7

TABLE B-28 (Contd)

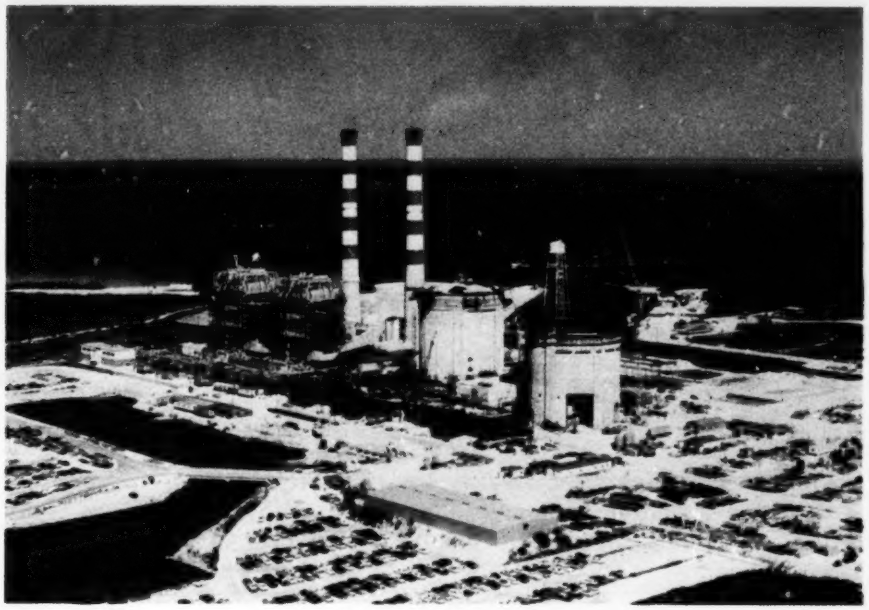
DAILY MAXIMUM, MINIMUM AND MEAN WATER TEMPERATURES (^{O}F) RECORDED BY THERMOGRAPHS AT STATIONS IN LOWER BISCAYNE BAY BETWEEN AUGUST 12 AND AUGUST 27, 1968

BIOLOGICAL EFFECTS
OF
THERMAL DISCHARGES
BISCAYNE BAY
FLORIDA

Department of the Interior
Federal Water Pollution Control Administration
Southeast Region

In recent years considerable attention has been given to the biological effects of thermal discharges on the biota of receiving waters. This attention has been generated in large part from the advent of large scale nuclear power generating facilities in the United States. One such facility is under construction on the lower east coast of Florida in Biscayne Bay south of Miami. At the present time, two fossil fuel units are in operation with two nuclear units to be completed by 1973.

The Southeast Region of the FWPCA has been investigating the lower Biscayne Bay area as part of its Lower Florida Estuary Study which was requested by the Governor of Florida. During the summer of 1969, biological effects of thermal discharges from an existing facility were observed and photographed by a project biologist (Mr. Lee Purkerson). The following photographs show damages that occurred to the flora and fauna in the vicinity of the heated water discharges. The photographs were taken following a large biological kill which occurred when the power plant increased its power generation beyond its normal operating level.



1. TURKEY POINT POWER PLANT

At present, there are two 432-million-watt fossil fuel units.

Two 760-million-watt nuclear steel units are under construction.

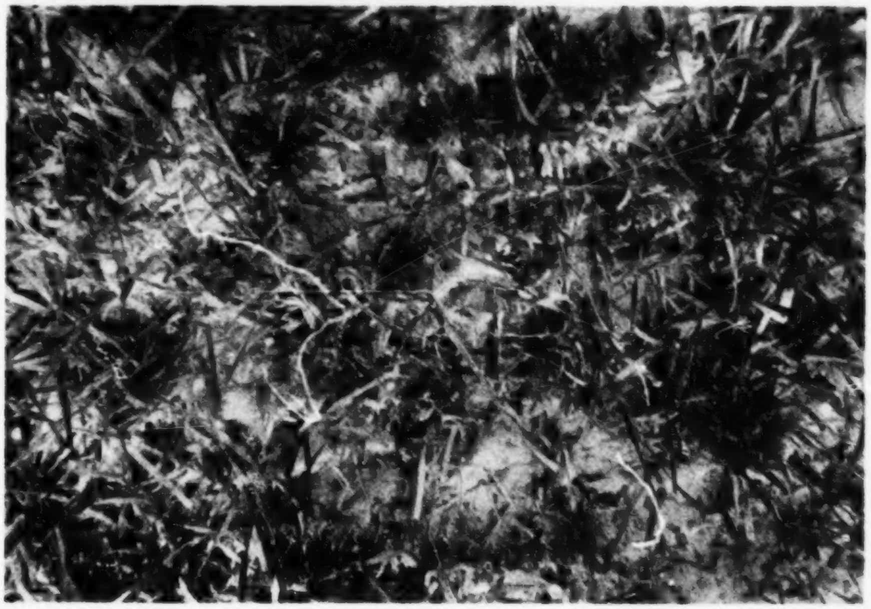
2. LOWER BISCAYNE BAY

A barren zone of Grand Canal, the principal hot water discharge canal.

The barren zone was caused by the heated discharge from the power plant.

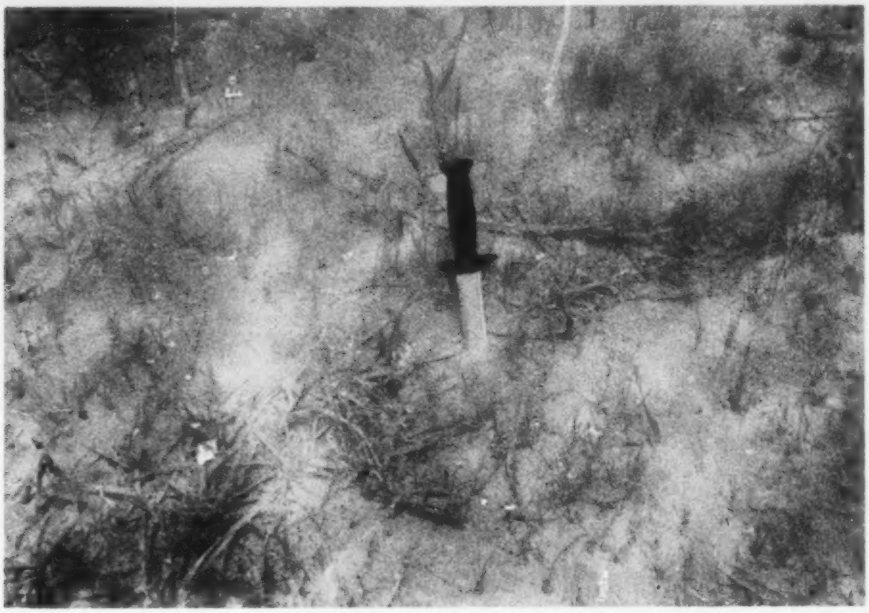
3. NORMAL UNDISTURBED FLORA OF LOWER BISCAYNE BAY

Beds of Thalassia, or Turtle Grass. Thalassia is the dominant vegetation in in-shore areas and is highly productive. It produces copious amounts of organic material which is a source of food for fish and serves as a cover for a multitude of small fish and inverterbrates.



4. BED OF THALASSIA 500 YARDS DUE EAST OF GRAND CANAL, JUNE 1969

Thalassia shows early damage.

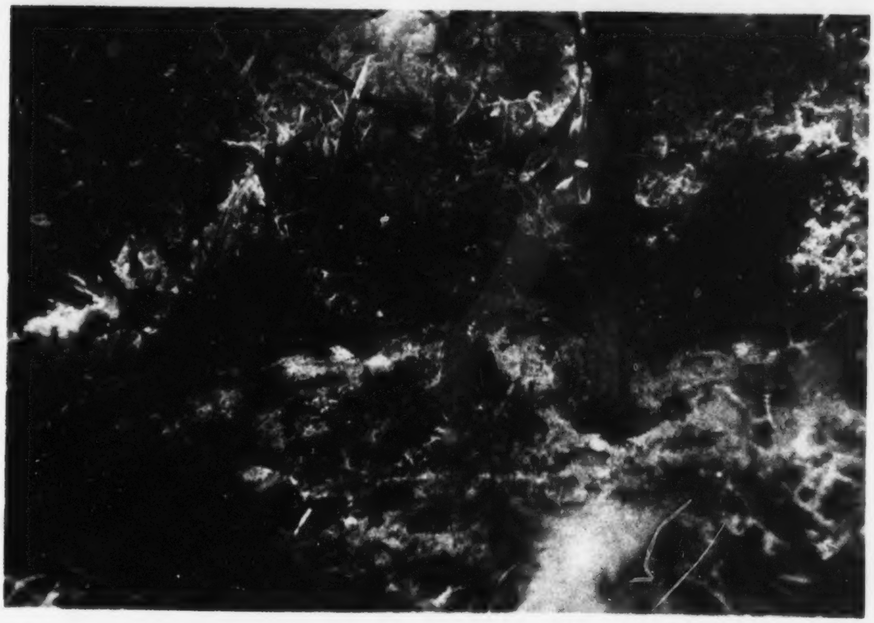


5. SAME AREA, AUGUST 1969, AFTER EXPOSURE TO MAXIMUM TEMPERATURE

6. ORANGE SPONGE

A sponge typical of animal life outside near-shore areas. When it is found within damaged area it shows a remarkable resistance to heat.

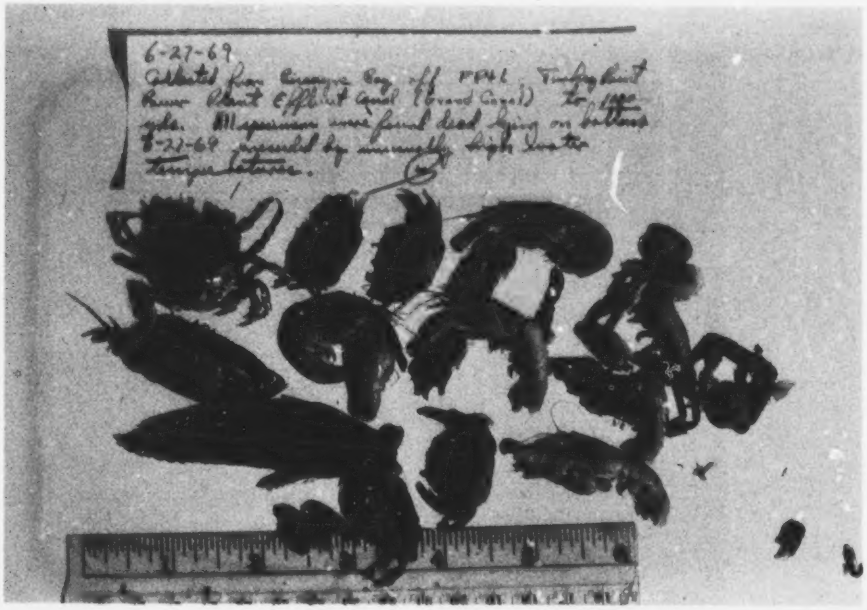
7. SPONGES (JUST OUTSIDE THALASSIA BEDS) IN VARIOUS STAGES AFTER BEING KILLED Three different kinds of sponges were killed in the June biological disaster. Note burned green algae in lower right corner.



8. SAME SPOT IN LATER STAGE OF DECOMPOSITION

9. COLLECTION OF BAY CORALS, OR ESTUARINE CORALS, AND MOLLUSKS, GATHERED IN THE AREA AND PLACED AROUND A DECAYING SPONGE

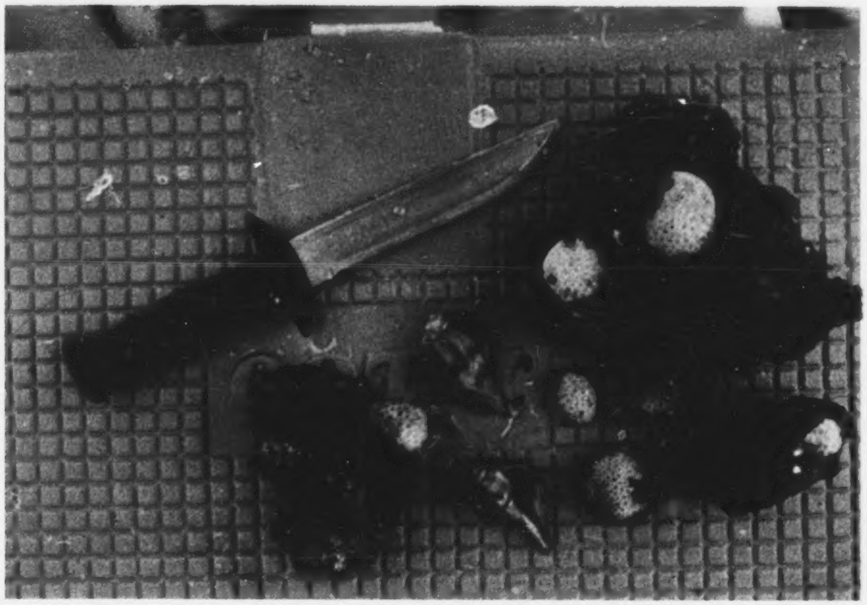
These estuarine corals had been damaged by temperature rise, but were eventually wiped out.


6-27-69
Collected from Biscayne Bay off FP&L Turkey Point Power Plant Effluent Canal (Grand Canal) to 1000 yds. All specimens were found dead lying on bottom 8-27-69 caused by unusually high water temperatures.

10. DEAD SPIDER CRABS, TINY BLUE CRABS, BURROW-DWELLING FISH, CLAM CHIONE, AND PISTOL SHRIMP

11. SPIDER CRABS, BLUE CRABS, STONE CRABS, BANDED TULIP SNAIL, SPRING LIMA CLAM, BAY CORAL, DEAD SPONGE (UPPER CENTER), DEAD ALGAE (UPPER RIGHT)

Stone crabs and blue crabs were collected at mouth of Grand Canal. Others were collected along a 70-degree transect beginning at 1500 yards from the mouth of the canal.



12. BAY CORALS AND WELK SHEELS

These organisms were killed in an area 1000 yards south and 500 yards east of the mouth of Grand Canal.

13. A TYPE OF SPONGE THAT WAS DECIMATED IN THE AREA

Photograph was taken in late June.

14. BED OF CAULERPA, A SPECIES OF ALGAE

Caulerpa, very sensitive to adverse environmental conditions, was wiped out in an area to 1500 yards NNE (along 70-degree transect). This photograph was taken just outside area of acute damage.

John Hagan

MR. HAGAN: Biscayne Bay is a shallow subtropical estuarine lagoon lying on the extreme southeastern tip of the Florida peninsula south of Miami. The bay is semi-enclosed, being separated from the Atlantic Ocean by a narrow chain of barrier islands. Broad shoals and deep narrow tidal surge channels provide the connection to the ocean (Figure 1).

Lower (southern) Biscayne Bay is an area approximately 11 miles long by 9 miles wide and is bounded on the west by the Florida mainland, on the north by Featherbed Bank, on the east by the Florida Keys, and on the south by Cutter Bank. The bay is shallow, with a maximum depth of 13 feet and an average depth of between 5 and 6 feet at mean low water (MLW). The mean tidal range near Homestead on the western shore is 1.65 feet and at Elliott Key on the eastern shore is 1.54 feet.

Card Sound is a relatively small basin adjacent to Lower Biscayne Bay. Card Sound is separated from South Biscayne Bay by the Arsenicker Keys and by the shallows formed by Cutter Bank. It is bounded by north Key Largo on the east and separated from Little Card Sound on the south by Card Bank.

John Hagan

Card Sound is roughly 3 miles wide by 5½ miles long. The average depth at mean low water is about 9 feet; however, the major portions of Card Sound are uniformly about 10 feet deep at mean low water.

With the exception of Card Bank at the southern end and Cutter Bank at the northern end, Card Sound does not have the extensive shallow "grass bed" shoreline typical of Lower Biscayne Bay. The bordering subtidal shallows drop precipitously into a deeper Card Sound Basin.

The tidal exchange of water between Card Sound and Lower Biscayne Bay is over the shallows of Cutter Bank, which at mean low water ranges from 6 inches to 2 feet deep. Flow to the south must pass over Card Bank and through the narrow passage from Little Card Sound to Barnes Sound.

Exchange of Card Sound water with the ocean is confined to the surge channels or creeks at north Key Largo; namely, Angelfish Creek and Broad Creek. Before these channels enter Card Sound, they form shallow dendrite paths over the top of shallow banks from 1 to 4 feet deep at mean low water.

The input of freshwater to Card Sound from land drainage is limited to runoff from Key Largo, the mainland east of salt water barrier levee, and from the Model Land Canal. Thus, freshwater input is most likely limited to the small drainage southeast of Florida City and is intermittent with slugs of freshwater to the Sound during and following periods of heavy rainfall.

The climate of Dade County is warm and mild and may be described as subtropical. Extreme temperatures range from the mid nineties in July or August to mid thirties in January or February. However, average temperatures for July and August are about 82°F and for January and February are about 69°F. Annual rainfall is about 60 inches with 75-80 percent occurring June through October. During that same period, the relative humidity is quite high, ranging from 60-90 percent of saturation.

IV. WATER USE

At present, Biscayne Bay is used for commercial and sport fishing, shellfishing, commercial sponge harvesting, sailboating, motor boating, wading, skiing, swimming, snorkel and SCUBA diving and aesthetic enjoyment.

Few places in the world have more beautiful or spectacular birds than South Florida. Most important in Biscayne Bay are the wading and shore birds. These are found principally in the shallows, extensive mangrove shoreline and the small mangrove islands in the extreme south portion of the bay. Several species can usually be seen wading in the shallows, among them some of the rare and endangered species. Birds commonly observed include heron, pelican, cormorant, egret, white ibis, roseate spoonbill, frigate birds, waterfowl, gulls and terns.

Plants of Biscayne Bay serve a valuable ecological purpose, including the production of a rich substrate supporting and sheltering invertebrate population and stabilizing the bay bottom and the shoreline. The richly vegetated bay bottom serves as a nursery for the valuable sport and commercial fishery and has an important role in the productivity of all the marine resources in the area. These animals and plants are the nutrient base of all life in the bay.

There are in Biscayne Bay at least 27 species of fish which are of major importance for commercial, sport, or bait fishing, including mullet, barracuda, mackerel, Jack, snapper, grouper, bonefish, snook and pompano. There are at least nine invertebrates occurring in the bay which are of major importance. These include sponges, queen conch, blue crab, stone crab, shrimp, and spiny lobster. In addition, there are at least 18 species which are of minor commercial significance.

In 1965, bait shrimp fishery alone had a value of $393,600. Stone crabs were the second most valuable commercial fishery, netting a catch valued at $145,828 in 1965. Spiny lobsters from Biscayne Bay brought $81,000 to commercial lobstermen. In addition, a considerable but unrecorded sport fishery also exists.

For residents of South Florida, Biscayne Bay offers the most convenient, attractive and diverse recreational opportunities. It is projected that 2.7 million people will reside in the 4 county area (Dade, Broward, Palm Beach and Monroe) by 1980. Of that number, approximately one million will be in the 18-44 age group -- the active years for outdoor recreation. By that time, an estimated 1.36 million instances of participation in outdoor recreation will occur, of which water-oriented activities will account for about 78 percent.

According to a 1967 tourist study conducted by the Florida Development Commission, 73 percent of the tourists entering Florida by all means of transportation looked forward to beaches and swimming.

The Congress of the United States, on October 18,

John Hagan

1968, enacted PL 90-606 authorizing $24,575,000 for the purchase of property for the Biscayne National Monument and $2,900,000 for Monument development. In doing so, the Congress recognized the unique value of this subtropical estuary lagoon area and set it aside as a preserve for the enjoyment of the public. The purpose of authorizing the Monument's establishment was to "... preserve and protect for the education, inspiration, recreation, and enjoyment of present and future generations a rare combination of terrestrial, marine, and amphibian life in a geographical setting of great natural beauty ...".

The Biscayne National Monument would be located in Lower Biscayne Bay, approximately 20 miles south of Miami. The entire area within the Monument would be about 11½ miles from north to south and an average of 12 miles from east to west. It would consist of about 96,300 acres, 3,900 acres of which are land and mangrove swamps consisting of the Upper Florida Keys, a chain of narrow islands separating Biscayne Bay from the Atlantic Ocean. About 92,400 acres (approximately 96 percent) are submerged, consisting of the adjoining bay and ocean waters, and is accessible only by boat.

John Hagan

The boundaries of the Monument would encompass some 33 islands and keys lying between but not including Key Biscayne and Key Largo. The keys included in the Monument are among the most northerly of the chain of islands stretching from Virginia Key, just south of Miami Beach, to Key West and beyond. Principal keys within the area are the 1,700-acre Elliott Key and Sands, Adams and Rhodes Keys; many other keys a fraction of an acre in size would also be included.

On the north, the boundary runs between Boca Chita and Sands Keys; on the east it follows the 60-foot depth line in the Atlantic Ocean; on the south it runs along the northern boundary of a possible shipping channel entering into Broad Creek; on the west it generally follows the outer dredging limit line established by the Dade County Commissioners, generally parallel to and within 400 to 1,000 feet from the mainland. The extension of the west boundary of the Monument to near the mainland is intended to protect the submerged lands of Biscayne Bay from unwarranted channel development, commercial dredging and filling, pollution, and other activities which may alter or upset the marine ecology and underwater circulation patterns.

John Hagan

Title to all but about 400 acres of the submerged land in Biscayne Bay plus part of the submerged land on the ocean side of the keys is held by the State of Florida. The remainder is held by the United States. The State, by resolution dated July 9, 1968, acting through its Internal Improvement Fund (IIF), has agreed to turn over State-owned submerged land to the United States subject to (1) congressional authorization and designation of the proposed Monument, and (2) congressional authorization for appropriation of Federal funds for acquisition of all non-federally owned lands within the Monument area, with such acquisition to provide just compensation to owners.

An area not to exceed 80 acres has been planned on the mainland as a headquarters site near Homestead Bayfront Park, and an area not to exceed 40 acres is also planned on Key Largo as a secondary visitor contact station along Card Sound in the northern part of Key Largo. This would provide access to the Monument from Card Sound.

A visitor contact point is projected at Elliott Key. Developments are planned for shelters, enlarged docking facilities and primitive campgrounds at this location. Fishing, diving, snorkeling, bicycling, picnicking and hiking may be enjoyed.

A secondary public-use facility to supplement the one on Elliott Key would be on Sands Key to the north. Visitor contact, picnicking, and boat docking will be available. A similar facility would be located on Adams Key to the south.

The results of an economic study of the Monument's feasibility include the projection that by 1975 approximately 750,000 persons will be visiting the Monument on an annual basis, and the related annual expenditure at or near the park has been estimated to be $9,150,000.

V. TURKEY POINT POWER PROJECT

A. Present Operation

The Dade Metro Commission granted the Florida Power & Light Company a permit in June 1964 and construction of the two oil-fired units (referred to as Units 1 and 2) began in September of that year. Unit 1 was placed on line April 22, 1967 and Unit 2 went into operation April 25, 1968. These two conventional (oil-fired) units represent the presently installed capacity of the Turkey Point Power Plant. The plant is located on 3500 acres at and adjacent to Turkey Point.

Units 1 and 2 each have 432,000 KW maximum capacity, with normal load capacity of 360,000 KW. Each unit requires 635 cubic feet per second (cfs) of condenser cooling water, or a total of 1270 cfs (820 million gallons a day) for both units. Water for cooling purposes is drawn from Biscayne Bay at an intake located just north of and immediately adjacent to Turkey Point. It is discharged back into the bay about two miles south of Turkey Point via a series of canals located on FP&L property.

The amount of water flowing through the condensers remains constant so that the rise in water temperature is a function of power generation load. Projected temperature rise across the condenser at various power loadings is shown in Figure 3. At the normal full load of 360,000 KW the temperature rise is approximately 12°F and at maximum capacity of 432,000 KW the temperature rise is approximately 14°F.

Hourly observations of power load at the Turkey Point plant and for the Florida Power & Light system as a whole for the months of June, July and

August 1969 were supplied by the company. These data indicate a wide daily fluctuation in power demand at Turkey Point ranging from 150,000 KW to over 780,000 KW. The highest peak occurs in the mid-to-late afternoon reflecting the summer air-conditioning demand. Typical winter and summer load curves prepared by Florida Power & Light are shown in Figure 4.

Figures 5, 6 and 7 show the frequency with which the expected temperature rise was equalled or exceeded during June, July and August 1969, respectively, at the Turkey Point installation. In June, the temperature rise across the condensers exceeded 3.3°F 100 percent of the time; it exceeded 9.9°F 50 percent of the time, and it exceeded 12.0°F 16 percent of the time. As a result of a fish kill which occurred on June 25, 1969 in Lower Biscayne Bay, operation of the Turkey Point plant and the South Florida power network was modified so that the Turkey Point plant would be the last plant to go to peak load and the first to come down from peak load.

As a result, the temperature rise frequency distribution for July 1969 shows a considerably different pattern from that in June. In July, the temperature rise exceeded 6.3°F 50 percent of the time, and exceeded 12°F

5.5 percent of the time. In August, the frequency of the 12°F temperature rise increased to 16.4 percent of the time. Fifty percent of the time the temperature rise equalled or exceeded 9.8°F, and a rise of 3.3°F was equalled or exceeded 100 percent of the time.

B. Planned Operation

On November 15, 1965, the company announced plans to construct two 760,000 KW nuclear powered units at Turkey Point. Permits were acquired from the Atomic Energy Commission and the Dade Metro Commission. Construction was begun in early 1967 on Units 3 and 4. Construction is expected to be completed and the first nuclear unit on line in 1971. The second nuclear unit should go into service in 1972.

Each nuclear unit has a normal full load output of 680,000 KW and a maximum capacity of 760,000 KW. Condenser cooling water volume required is 1490 cfs per unit or a total of 2980 cfs. When combined with the fossil units, a total of 4250 cfs or 2.75 billion gallons a day of cooling water will be required at the Turkey Point generating facility.

Figure 8 shows the predicted temperature rise across the condensers of Units 3 and 4 under various power load demands. Under normal full load, the temperature rise would be 15.2°F and at maximum load it will be 16.8°F.

The combined temperature rise when all units at Turkey Point are operating under normal full load will be 14.2°F. Under maximum power demand the temperature rise will be 15.9°F.

The predicted waste heat load will be approximately four times as great with the nuclear units in operation as at present (0.98×10^6 BTU* per second at present; 3.9×10^6 BTU per second in the future at normal full load.)

VI. STATUS OF THERMAL CONTROL PROGRAM

Subsequent to the start of operation of Units 1 and 2, and after the issuance of the construction permit for Units 3 and 4, the Florida Power & Light Company, on October 16, 1968, applied to Dade County for a temperature variance. This variance was granted on February 20, 1969 and expired on July 31, 1969.

The Dade County temperature standard states that temperatures shall not be raised artificially to exceed 95°F. Water quality standards adopted by the State of Florida contain the following statement: "(The temperature) shall not be increased so as to cause any damage or harm to the aquatic life or vegetation of the receiving waters or interfere with any beneficial use assigned to such waters."

---

* British Thermal Units

All of Biscayne Bay is designated Class III: Recreation, Propagation and Management of Fish and Wildlife.

Beginning on June 23, 1969, a series of hearings was held by the Metropolitan Dade County Pollution Control Hearing Board. On November 18, 1969, the board granted an extension of the temperature variance until July 1, 1971.

Florida Power & Light Company has presented a plan calling for: providing cooling and dilution water from Biscayne Bay, transporting the heated effluent to Card Sound via canal, and discharging 8500 cfs of cooling water at elevated temperature into Card Sound. At the present time, the company discharges heated effluent through a system of canals directly to Biscayne Bay approximately two miles south of the plant.

VII. WATER QUALITY

A. Review of Previous Data

Water quality studies have been conducted in

Lower Biscayne Bay and Card Sound by several organizations including the Department of the Interior, the University of Miami Institute of Marine Sciences, and Florida State Board of Health.

Conclusions of a State Board of Health report in 1962 were: 1) "The area of Biscayne Bay covered in this survey (between Featherbed Bank and Turkey Point) is chemically the equivalent of good, clean ocean water. Some freshwater influence is apparent at the sampling points in the general vicinity of the canal outfalls. 2) (Biologically) The lower part of the bay near Homestead is in a completely healthy condition. 3) The effluent from the Homestead sewage treatment plant...has caused a noticeably heavier growth of bottom vegetation near the mouth of the canal."

4) Actual data are not available to describe the load entering the bay from the Homestead sewage treatment plant; however, the 1962 Inventory of Municipal Waste Facilities shows a population of 8050, served by a biological secondary treatment plant which discharged an estimated population equivalent of 800.

Unpublished data collected by the Institute of Marine Sciences, University of Miami, are primarily hydrographic, consisting almost entirely of temperature, salinity, and dissolved oxygen measurements. Examination indicates that during the summer months there are instances of dissolved oxygen concentrations reaching 3.0 mg/l or lower for short periods of time. Data collected early in the morning have generally lower DO values than samples collected during midday or afternoon. This pattern is indicative of normal diurnal variations resulting from biotic respiration and has been observed during FWPCA round-the-clock surveys. Other than the instance above, all other data indicate that dissolved oxygen levels are well above 4.0 mg/l, the official Florida criterion.

Researchers at the University of Miami, School for Marine and Atmospheric Sciences, studying the effects of thermal pollution from Florida Power & Light's Turkey Point powerplant have identified 58 species of fish, 87 molluscs, 46 crustaceans, 15 sponges, 16 echinoderms, 25 polycheates and 5 miscellaneous animals collected in the vicinity of Turkey Point. In addition, 25 species of algae and marine "grasses" have been identified.

B. FWPCA Field Activities

Water quality studies were conducted in Lower

Biscayne Bay between September 30 and October 2, 1969, and on January 17, 18 and 19, 1970. Samples were collected from the surface and bottom at two-hour intervals for a period of 48 hours at five locations adjacent to Turkey Point and east of Grand Canal, the major discharge point for the cooling water.

Air temperatures during the survey ranged from 74 to 91°F and averaged 83.2°F. Winds were generally from the south and varied from calm to 15 knots. Strongest winds were accompanied by a severe rain squall on the morning of October 2. Rain occurred intermittently throughout the survey, with showers during the early morning and early afternoon. Associated cloud cover was quite heavy, generally above 50 percent. Seas were generally choppy but became calm around sunrise and sunset, and rough during squalls.

Highest water temperature occurred at Station H-1-T (500 yards east of Grand Canal). Temperature ranged from 84.0 to 93.5°F and averaged 89.2°F. Near the bottom at this Station (H-1-B), temperature ranged from 84.0 to 89.0°F and averaged 86.2°F. Analysis of the variance about the mean of these two data sets shows that the 3°F difference is significant and indicates that the bay is thermally stratified at that point. No other station exhibited this degree of stratification.

Temperatures at Station H-3 averaged 84.5 and 84.7°F at top and bottom, respectively. At Station H-6, 3,000 yards east of Grand Canal, both top and bottom temperatures averaged 84.3°F.

Station E-2 is within the northward path of the heated water plume. Temperatures there were elevated to 88°F with no significant thermal stratification. Analysis of variance of the mean temperature at Stations H-1-S and E-2-S shows that the difference (1 degree F) is statistically significant. Similarly, the difference between E-2-T and H-6-T (3.9°F) is also significant.

Station J-1 is occasionally within the southern influence of the heated water plume. The temperature curve follows very closely the chloride curve, indicating that on flood tide the heated water is against the shore and expands to the south against its normal northward flow pattern. Temperatures at J-1-T and J-1-B averaged 85.2 and 85.4°F, respectively, and were significantly different from those at Station H-1 but exhibited no statistically significant vertical thermal stratification.

John Hagan

At a recording monitor control station away from the influence of elevated temperature, on the southeast side of Arsenicker Key, the maximum temperature was 85°F and the minimum 84°F. The increase in temperature due to the cooling water discharge averaged 4.7°F and the maximum increase was 9°F. Temperature variation 500 yards east of Grand Canal was 9.5°F. Temperature variation at the control location was 1°F.

Concentration of Chloride at Station H-1-T was the lowest of any station tested and averaged 11.9 gm/l. Concentration varied widely (9.9 to 14.2 gm/l), probably due to the frequent and locally heavy thunder storms and resultant runoff.

Station E-2-S, located some 1500 yards north and 500 yards east of Grand Canal, had an average Chloride level of 13.0 gm/l. Station H-3, 1000 yards east of H-1, had an average of 14.8 gm/l. This reaffirms that water discharged from the canal moves northward along the shore. It also indicates that the less dense heated water, when combined with less dense surface drainage, produces an effluent which does not readily mix with the cooler and more saline waters of Biscayne Bay. This suggests a moderate to low coefficient of turbulent diffusion. Station J-1 also had slightly reduced Chloride levels, further supporting this hypothesis.

Station H-3 shows very weak salinity stratification (500 mg/l in 5-foot depth) and Station H-6 had no vertical salinity stratification. There was less than 2.0 gm/l difference between the means of Station H-3 and H-6, indicating a narrower zone of fresh-water influence in the easterly direction than in the northerly direction.

The lowest DO reading was 3.69 mg/l at Station E-2-B. The highest value of 9.65 mg/l was also observed at E-2-B. Diurnal variations were observed at all stations. These variations were generally the same magnitude at surface and bottom stations. The diurnal cycle of the DO curve in contrast to the 12.4 hour tidal cycle shows that the DO variations are not strongly related to the tide stage.

Alkalinity remained relatively constant throughout the sampling program. The greatest variation was from Station H-1 to H-3 to H-6. From a mean of 136 mg/l at H-1-T, the alkalinity dropped to 127 mg/l at H-3-T and 118 mg/l at H-6-T. It is interesting to note that alkalinity at H-3-B (118 mg/l) is the same as

H-6-T. This, along with the chloride concentrations, is evidence of some stratification at H-3, probably in the nature of a salt wedge.

The immense buffer capacity of sea water is reflected in the constant pH. Station H-1-T, which has already been shown to be different water from that at other stations, shows a pH of 7.8. This 0.1 pH unit is below the general level of the bay and is not considered a significant factor, especially in the light of the slightly higher alkalinity discussed above.

Turbidity was consistently low, having a maximum of 15.0 Jackson Candle Units (JCU) in one sample from Station H-1-B. The highest average value was also at H-1-B (4.8 JCU). The average at that station, disregarding the single high value, was 3.3 JCU.

Combined nitrite and nitrate nitrogen exhibited the highest average concentration at Station H-6-B, with 0.036 mg/l as N. The highest individual concentration was 0.060 mg/l at Station E-2-B at a high tide condition.

Highest values of total Kjeldahl nitrogen occurred at Station H-1. At that station, average concentration -- both top and bottom -- was 0.36 mg/l as N. At every station, Kjeldahl nitrogen was either the same top-to-bottom or the bottom sample was slightly higher.

Biochemical oxygen demand (5-day, 20°C) was, without exception, extremely low. Maximum observed BOD on an individual sample was 0.7 mg/l.

These data confirm that Lower Biscayne Bay is almost totally free of man-made organic pollution.

A second water quality survey was conducted on January 17, 18 and 19, 1970. Highest temperatures occurred at Station H-1 (Figure 9), ranging from 66.0°F to 79.0°F and averaging 75.5°F for the 48-hour period. Temperatures at Station H-3 averaged 69.0°F, while at Station E-2 they were 71.5°F, reflecting the northward movement of the heated water plume. Station K-2, south of the mouth of Grand Canal, also shows the influence of heated effluent with a temperature of 70.0°F, both top and bottom. Temperatures at Station H-6, 3000 yards east of Grand Canal, ranged from 66.0°F to 70°F, and averaged 68.0°F (Table 3). Temperature at the monitor control station averaged 70°F. This was 5.5°F less than that observed 500 yards east of the Grand Canal.

Chloride concentrations were generally higher

John Hagan

than in the September survey, reflecting the seasonally reduced rainfall and freshwater inflow. Most stations showed 0.2 gm/l or less difference from top to bottom.

Dissolved oxygen was consistently high throughout the sampling period with a minimum value of 4.0 mg/l occurring at Station K-2-B. Maximum values were as high as 9.5 mg/l. There was no significant difference between dissolved oxygen concentrations in the mouth of Grand Canal and in the open bay.

Biochemical oxygen demand was higher during this survey than in the September study. A maximum value of 4.9 mg/l was observed at Station H-6-B. There is no readily apparent explanation for this phenomenon. The distribution does not show any relation to sources of waste.

Again other water quality data was done in connection with this survey, and again, as in the previous study, all other chemical parameters measured were found in extremely low concentrations. Turbidity had a maximum value of 2 JCU.

It is concluded from these investigations that the water quality of Biscayne Bay as measured by the standard chemical indicators is of extremely high purity and that no pollution is present which might cause damage to the aquatic environment.

A water quality survey was conducted in Card Sound on January 15, 1970. Five locations were sampled, top and bottom, at two-hour intervals for a period of fourteen hours.

Temperatures in Card Sound ranged from 71.5°F at Station CS-1 to a low of 60.0°F at four stations. Highest average temperature 66.5°F; also, at Station CS-1. Temperature stratification was apparent at the two stations in and near the mouth of Model Land Canal, with the warmer water lying on top.

Chloride data confirm a two-layered system near the mouth of Model Land Canal. Average chloride concentrations are 13.9 and 14.3 gm/l at Stations CS-5 and CS-1, respectively, while the bottom samples have chloride concentrations of 16.2 and 16.5 gm/l. All other stations show 0.2 gm/l or less difference between top and bottom, and these concentrations are all above 16.0 gm/l. These data indicate that Card Sound is more saline than Biscayne Bay -- and this factor, together with the deeper water, provides a more oceanic habitat than that of Lower Biscayne Bay.

John Hagan

Dissolved oxygen levels were consistently high, with a minimum value of 5.0 mg/l and a maximum of 11.5 mg/l. Throughout Card Sound, the dissolved oxygen averaged about 8 mg/l. Weak but distinguishable oxygen stratification was noted at the two stations near Model Land Canal, with the lower values associated with the warmer and fresher water.

The highest ammonia and nitrate concentrations were at the mouth of Model Land Canal and were 0.10 and 0.035 mg/l, respectively. Maximum total Kjeldahl nitrogen of 0.88 mg/l occurred at Station CS-1. All total phosphate concentrations were below 0.05 mg/l.

Turbidity concentrations were 4 JCU maximum at Station CS-5 and generally 1 JCU through the Sound. Alkalinity ranged from 152 to 169 mg/l. Five day BOD in Card Sound showed a maximum concentration of 3.2 mg/l.

From these data, it is concluded that the water quality of Card Sound is excellent and that no pollution is present which might cause damage to the ecosystem of Card Sound.

C. Circulation (Lower Biscayne Bay)

A tracer study was conducted in Biscayne Bay in the vicinity of Turkey Point January 12-13, 1970.

John Hagan

The specific purpose of this dye study was to determine the distribution of the FP&L powerplant condenser cooling water discharge in Biscayne Bay.

Two hundred fifty pounds of 20 percent Rhodamine WT dye (50# of dye) was instantaneously discharged into Grand Canal at high-water slack (HWS) on January 12. Samples were collected on an hourly schedule at the water surface and bottom at each of 16 stations for the next 24-hour period.

The dye moved very slowly initially, taking approximately 45 minutes to one hour to clear the mouth of the effluent canal (Figure 11). After exiting from the canal, the dye began to rapidly disperse and move northeastward on the ebbing tide. Peak concentrations were found just east of Turkey Point, between high-water and low-water slack conditions. Just after low-water slack conditions, the peak concentrations continued to move northeastward. Approximately 1½ hours before high-water slack (@ 2:38 on 1/13/70), the dye-patch began moving south; two hours and 22 minutes after the high-water slack, the dye-patch was located approximately 1.1 miles northeast of the mouth of Grand Canal.

The dye, and hence heated water from the

FP&L effluent canal, moves northeastward from the canal spreading over a large area of Biscayne Bay adjacent to Turkey Point and is persistent in concentration. The effluent from the canal is slowly dispersed, and is not readily flushed from the area. Thus, any cooling of water in the bay primarily occurs through exchange with the atmosphere rather than by mixing and dilution.

D. Temperature Effects

The Federal Water Pollution Control Administration conducted thermal studies of Lower Biscayne Bay from April to August 1968. This report is included as Appendix 1 given to Court Reporter. Monitoring on a reduced scale was continued through the winter, spring and summer of 1968-69. In the late summer of 1969, full-scale thermal studies were again undertaken.

During the April-August 1968 study, a total of ten stations were established, several of which were beyond any possible influence of the heated water effluent. Maximum temperatures at stations close to the discharge canal were from 3° to 9°F higher than at control stations, and statistical analysis showed that these differences were significant and not merely the result of natural diurnal variation.

Furthermore, the daily fluctuations in temperature were much greater at the stations near Grand Canal than at the control stations. Two control stations (C-6 and E-9) had maximum daily temperature fluctuation of 3° to 4°F, while two stations near Grand Canal (H-13-A and H-14) had maximum daily fluctuations of 9° and 7°F, respectively.

The maximum hourly rate of temperature change was found at stations H-13-A and H-13 and amounted to 3°F per hour.

Numerous isotherm plots under various wind and tide conditions indicated that the movement of the heated water was in a generally northeasterly direction around Turkey Point.

A critical temperature condition occurred in June 1969. Figure 12 shows the percent of the time the temperature equalled or exceeded various levels at each of two stations along a 75-degree transect from Grand Canal. At 300 yards, the maximum daily temperature equalled or exceeded 90°F on all days. The maximum daily temperature observed was 103°F. At 1200 yards off Grand Canal, the maximum daily temperature exceeded 90°F on 43 percent of the days and reached a maximum of 97°F.

These maximum temperatures resulted in a massive fish kill which will be described in subsequent sections of the report.

The first full month for which data are available from the present temperature monitoring program is August 1969. Figure 13 shows the location of the automatic monitors. Temperatures as high as 95°F occurred up to 1000 yards east and 1500 yards north of Grand Canal. The isotherms of the monthly mean of the daily maximum temperature indicates that the 90°F isotherm extends 1000 yards east, 1000 yards south and to the shores of Turkey Point on the north, or an area of at least 620 acres.

The isotherm field of temperatures which were equalled or exceeded 10 percent of the time during August 1969 indicates that temperature of 90°F was exceeded throughout an area of over 620 acres.

The observed monthly maximum temperature isotherms for August 1969 (not necessarily simultaneous occurrence) indicate that, in the affected area, temperatures were in excess of 92°F and were as high as 99°F.

Temperatures were also measured at the cooling water intake location north of Turkey Point. The mean temperature during August 1969 was 85.5°F. The mean of the maximum daily temperature was 86.0°F. The maximum temperature observed during August 1969 was 88°F.

Cooling water effluent from the Florida Power & Light Turkey Point facility increased the monthly average of the maximum daily temperatures of at least 620 acres of Lower Biscayne Bay by more than 4°F. At the mouth of Grand Canal, the mean of the maximum daily temperature of 94°F during August 1969 was 8°F greater than intake temperature.

At this time I would like to turn the rostrum over to my colleague, Mr. Lee Purkerson, microbiologist from our staff who made the observations and measurements which went into the writing of the biological section of this report.

MR. STEIN: Thank you. That was a very comprehensive report.

Mr. Purkerson.

LEE PURKERSON, MICROBIOLOGIST,
LOWER FLORIDA ESTUARY STUDIES,
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION,
FORT LAUDERDALE, FLORIDA

Lee Purkerson

MR. PURKERSON: Mr. Chairman, Conferees, ladies and gentlemen, my name is Lee Purkerson. I am a microbiologist for the Lower Florida Estuary Studies located in Fort Lauderdale, Florida.

Biological effects:

1. Biscayne Bay.

Biological studies conducted in Lower Biscayne Bay by the Federal Water Pollution Control Administration in the vicinity of Florida Power & Light's Turkey Point powerplant were initiated during late July 1968.

a. 1968

Near the mouth of Grand Canal, a barren, lifeless zone of denuded sediments extending several hundred yards into the bay was noted. Closer inspection revealed that the denuded sediments were covered with what appeared to be irregular mats of green or bluegreen microalgae. There were, however, none of the rooted plants or attached benthic algae that dominate the subtidal aquatic vegetation common to similar areas of the bay where sediments of sufficient depth exist. The area of barren sediment extended from 200 to 300 yards into the bay in the shape of a lopsided fan, covering an area estimated at 8 to 10 acres.

Lee Purkerson

By late November 1968, an extension of the desolate area and marked erosion of exposed, unconsolidated bay sediments had occurred. Depressions within the affected area were filled with mangrove peat and decomposed Thalassia rhizomes, attesting to erosion deep into the soft sediments by swift currents at the mouth of Grand Canal. The area of denuded and seriously eroded sediments had increased in area to an estimated 40 to 50 acres. The soft, rich upper sediment layers were totally removed leaving the more consolidated mangrove peat, and in places, a layer of sand derived from dredging the canal.

Beyond the stark barren zone, in line with Grand Canal and well within the plume of heated water issuing from Grand Canal, a Thalassia bed was marked during mid-September which appeared unhealthy. Upon closer inspection, the turtle grass blades were found to be coated with a heavy gelatinous material composed partly of epiphytic growths. Most of the grass blades had lost their bright green color, their vigor, and appeared brown and lifeless. Dead leaves cast from the plants littered the sediments. Benthic algae and invertebrates common to grass beds unaffected by heated effluents were conspicuously absent from the area characterized by sick and dying grass. Control study areas in nearby turtle grass beds were found to harbor swarms of small forage fish, molluscs, hermit crabs, estuarine corals, and crustacea living within the grass bed, in and upon the sediment, and upon the Thalassia blades as well. In addition, a variety of sessile green algae and mats of drifting red algae carpeted the bay bottom in unaffected areas.

By mid-November 1968, the sickened grasses observed earlier had completely succumbed and been carried away, leaving the exposed sediments which had begun to erode. An underwater search of an area 500 yards offshore from the mouth of Grand Canal showed that few living plants remained and that none of the usual invertebrate animals populating "grass bed" environments remained. A zone of nearly complete destruction of the plant and animal life extended from the mouth of Grand Canal into the bay for 500 to 700 yards, affecting an overall area of about 100 acres. Beyond the limits of the area grossly affected by the heated effluents, extending to between 700 and 1000 yards offshore from Grand Canal, there was a transition zone characterized by varying degrees of damage. It is estimated that the total affected area, including the outer areas evidencing at least a moderate degree of damage, encompassed some 300 acres.

In early February 1969, the previously denuded and eroded sediments were covered by diatom growths, patches of _Diplanthera_, the hardy green algae _Batophora_, and a few red algae. There were few remains of the previous inhabitants of the area.

b. 1969

Biological studies in 1969 commenced on May 1. A transect was established extending from the mouth of Grand Canal, E-NE (approximately 75 degrees magnetic) into Biscayne Bay, a distance of 1500 yards.

Observations recorded during May and June showed that while areas outside the immediate vicinity of heated effluent influence had experienced a spring re-growth, a small area of perhaps 10 acres near the mouth of Grand Canal remained devoid of the characteristic near shore benthic communities common to South Biscayne Bay. Aerial photographs taken during mid-June 1969 clearly show the stark, barren sediments, pockets of mangrove peat and _Thalassia_ rhizomes, the calcareous sands washed from Grand Canal, and patches of _Diplanthera_ at the fringes of the bald area. Traces extending from the canal bayward were cut by boat propellers followed by erosion of sediments along the disturbed track. These observations were verified by underwater examination of the area. Underwater exploration also revealed a rock rubble habitat at the mouth of the canal where stone crabs (*Menippe* mercenaria) and blue crabs (*Callinectes sapidus*) had taken up residence. The exposed sediments near the mouth of the canal were colonized by green and bluegreen macro-algae and alternately by prolific growths of diatoms. The dominant form colonizing the sediments during May and June 1969 was identified as the green algae, *Boodleopsis pusilla*. The sediment situation was critical since macro-algae possess little ability to bind sediments, thereby protecting them from erosion by wave action and currents.

Mixed with the *Diplanthera* fringe at the outer edges of the barren zone were populations of *Acetabularia crenulata* and *Batophora oerstedi*, robust green algae that had re-established themselves during the cooler winter months. Beyond the fringe, at the 400-yard marker, a sparse growth of turtle grass (*Thalassia testudinum*) had developed from rhizomes that had been protected deep in the bay sediments. In addition to the Thalassia were a few sessile green algae of the genera Halimeda, Penicillus and Cladophoropsis; a few small coral colonies (Siderastrea sp.); chicken liver sponges, and a few other invertebrate animals. Thalassia regrowth at 400 yards was quite sparse; while at 500 yards, regrowth had become somewhat more dense. Progressively better colonization occurred with greater distance from the mouth of Grand Canal. Thus, the area between the 400-yard marker and 1200-yard marker along the 75 degrees transect was characterized by a gradient of increased density and diversity of both plant and animal life. Within this zone of regrowth a host of tiny immature crabs (several genera and many species represented), shrimp, a wide variety of molluscs, pistol shrimp (species of the genus Alpheus), corals (Siderastrea sp.), sessile green algae (species of the genera Halimeda, Penicillus, Caulerpa, Udotea, Cladophoropsis), hermit crabs, small bottom fish, sponges, and the ubiquitous red algal mat, had reestablished sizeable populations.

Outside the 500-yard marker, the characteristics of the bay floor undergo a transition from the uniformly deep organic-rich near-shore sediments to an area where sediments blend alternately with an exposed limestone base covered lightly with shell fragments and calcareous sand. On the outer edges of this zone, and on further into the mid-portions of southwest Biscayne Bay, deep sediments are confined to roughly circular pockets, perhaps 100 feet in diameter. These pockets of sediment are invariably dominated by turtle grass (Thalassia testudinum), mixed with smaller densities of sessile green algae. The surrounding lightly-sedimented limestone base supports a wide variety of attached plants and animals, including numerous types of sponges, corals, a wide variety of algae, gorgonians, brittle stars, tiny starfish, burrowing crustacea and worms, limpets, a multitude of molluscs, including many types of clams, snails, mussels, worm shells and scallops, as well as burrow-dwelling fish, and hermit crabs.

On June 5, 1969, changes in benthic populations were being noted in the areas affected by heated effluents from Grand Canal. Even though small fish, shrimp, crabs, amphipods, brittle stars, etc., were noted as close as 200 yards to the outfall, the coral colonies (Siderastrea sp.) had all expired at 400 yards and 600 yards, and some were dead at 800 yards. In addition, a temperature inversion was noted; that is, warmer water was lying on the bay bottom. By June 19, 1969, other species were disappearing, particularly at the inshore stations. The Thalassia bed at 600 yards had begun to lose its green color and was being coated by a grown gelatinous material. Some of the micro-algae had died at 800 yards; 50 to 70 percent of the corals were dead; the Thalassia was coated and epiphytiaed. At 1000 yards, an increasingly large percentage of the Thalassia blades were losing color and vigor. No noticeable problems were observed beyond 1000 yards.

On June 25, unusually turbid waters and concomitant high temperatures were noted. On June 27, the bay bottom along the transect was searched and numerous dead pistol shrimp, blue crabs, spider crabs, dead algae, stone crabs, and molluscs were found. Dead animals were particularly numerous shoreward from the 1000-yard marker. One June 28, the bay bottom from 1500 yards along the transect to the mouth of Grand Canal was thoroughly searched. The bay bottom was littered with dead plants and animals, including sponges, spider crabs, blue crabs, corals, pistol shrimp, clams, snails, mussels, and several varieties of fish in addition to the wilted and browned green algae, species of the genera Anadyomene, Udotea, Penicillus, Halimeda, Caulerpa, Rhizocephalus, Cladophoropsis and Dictyosphaeria.

Within the mouth of Grand Canal, the dead remains of from 30 to 50 stone crabs and blue crabs were found. Outside the mouth of the canal and to the 500-yard marker, blue crabs, stone crabs, pistol shrimp, and a variety of gastropod molluscs dominated the dead animals found. Beyond the 500-yard markers, were found dead sponges (including species of the genera Ircinia and Spheciospongia), a variety of dead sessile green algae, including species of the genera Caulerpa, Udotea, Penicillus, Halimeda, and Anadyomene; dead molluscs included the cross barred venus (Chione cancellata), prickly cockle (Trachycardium egmontianum), banded tulip (Fasciolaria hunteria), true tulip (Fasciolaria tulipa), calico bay scallops (Aquipecten gibbus), worm shells (Vermicularia spirata), limpets (Acmaea sp.), and others; killed crustacea included the previously mentioned pistol shrimp, blue crabs, and stone crabs. Thousands of dead fish were reported south of Turkey Point on June 26, 1969.

To determine the magnitude of the area of bay bottom affected and to assess the degree of damage caused

Lee Purkerson

by the overheating of the bay during late June, a grid pattern of study sites located at 500-yard intervals was plotted on a map to include the portions of biscayne Bay in the vicinity of Turkey Point affected by heated discharges. A thorough underwater examination, corresponding to the sites in the bay plotted on a map during July 1969 revealed severe damage to benthic plant and animal populations, including corals, sponges, sessile green algae, crustacea, and molluscs in an area extending 1000 yards east, 1000 or more yards north and 500 or more yard south from the mouth of Grand Canal. An area evidencing a moderate degree of damage to benthic inhabitants extended east-northeast from the mouth of Grand Canal to a point 1500 yards into Biscayne Bay. Dead and seriously damaged benthic plants and animals were observed along a line extending more than 1500 yards north and at least 500 yards south from a point located 1000 yards due east from the mouth of Grand Canal. The shape of the kill zone resembled the isotherm diagrams depicting the predominantly northeasterly flow of heated effluents past Turkey Point. The June 25 kill affected an area of Biscayne Bay totaling at least 570 acres. Observations conducted during mid- and late-July revealed that additional damage had occurred

Lee Purkerson

south from the mouth of Grand Canal which encompassed an additional 100 or more acres. Thus, the total estimated area of damage in Biscayne Bay, occurring during the summer months of 1969, based solely on the lethal effect of overheating, amounted to about 670 acres of bay bottom.

Excessive temperatures recorded on June 25 -- and for several days thereafter -- killed all of the crabs that had taken residence within the rock pile at the mouth of Grand Canal. The hardier plants occupying the fringe zone outside the denuded sediments off the mouth of Grand Canal were again eliminated. The _Thalassia_ that had regrowth at 500 yards was subject to a complete re-kill, with complete defoliation by September 1969. All other benthic life forms commonly inhabiting the grass bed environment were likewise absent.

Stations located 500 yards north and 500 yards south of a point 1000 yards due east of Turtle Point exhibited approximately 50 percent defoliation of _Thalassia_ by September 1969. The commonly associated sessile green macro-algae were sparse or absent; the vast majority of coral colonies were dead, and the benthic invertebrate population (snails, clams, sponges, etc.)

was drastically reduced. The empty shells of killed molluscs littered the substrate; particularly noticeable were the shells of the small mussel *Brachidontes Exutus* and the worm shell, *Vermucularia spirata*. Both of these species had become unusually abundant at inshore stations prior to the occurrence of excessive summer water temperatures. A large population of common intertidal scavenger snails (i.e., *Nassarius vibex* and *Prunun apicinum*), which had presumably responded to an increased food supply brought about by the demise of other species at centrally located study sites, was likewise appreciably reduced by excessive bay water temperatures. There were few species, and a small number of individuals, making up this surviving population that remained viable at these study sites.

At sampling sites located 1500 yards north and 1500 yards south from the mouth of Grand Canal and 1000 yards from shore, the skeletal remains of killed invertebrates were evidence of earlier damage. In some instances, however, there was partial regrowth of new living sponge tissue upon the skeletal remains. Some genera of sessile green macro-algae (i. e., *Penicillus* and *Halimeda*) had initiated new growth during late August and early September, whereas others were sparse, rare, or totally absent.

There was progressively less evidence of damage

Lee Purkerson

at stations 1500 yards east from the mouth of Grand Canal and at stations north and south from that point. Only the green macro-algae, *Caulerpa paspaloides*, *Caulerpa sertularoides*, *Udotea flabellum* and *Udotea congultinata*; the most sensitive sponges; the corals *Siderastrea sp*. and *Solenastrea hyades*; and certain common molluscs, i. e., *Vermicularia spirata* and *Brachidontes exutus*, were among those constituting the most dependable indicators of thermal stress and damage. Stations outside the area of thermal stress were inhabited by spiny lobsters (*Panulirus argus*), a large variety of swimming crabs, species of the genera *Callinectes* and *Portunus*, stone crabs, spider crabs, pistol shrimp (*Alpheus*), brittle stars (class, *Ophiuroidea*), tiny starfish (*Echinaster sentus*), a host of molluscs, sea anemonae, gorgonids, and all the other life forms comprising the normal flora and fauna of an undisturbed habitat common to Lower Biscayne Bay.

Degradation and destruction of bottom fauna and fish were observed in Lower Biscayne Bay in an area of 300 acres during 1968 and 670 acres during 1969. The area of biological degradation coincides with the observed area of increased water temperatures. During August 1969, water temperatures in the area of biological degradation were from 4°F to 8°F greater than the monthly mean of the maximum daily temperatures at the cooling water intake.

Water quality indicators, other than temperature, demonstrate excellent conditions. The cause of the biological degradation and destruction during 1968 and 1969 in Lower Biscayne Bay is the discharge of waste heat from the Florida Power & Light Company Turkey Point generating plant. The water quality standards of the State of Florida require no damage to aquatic life or vegetation as the result of increased temperature. This criterion is being violated by the discharge of cooling water from the Turkey Point generating plant.

2. Card Sound

A preliminary biological reconnaissance of Card Sound was conducted during late September 1969. Eight sites were selected at intervals across the south end, middle, and north end of the Sound. Two other sites near the mouth of Model Land Canal had been visited previously during the course of servicing thermographs.

The substrate of Card Sound is variable, with sand and shell dominating some areas and accumulations of soft sediments dominating other areas, with a blending of these into mixed sediment types between. As in Biscayne Bay, pockets of sediment are found isolated by a more solid substrate. These sediment pockets support a lush and varied flora, dominated by *Thalassia*.

A wide variety of benthic plants and animals was noted, including algae, species of the genera *Caulerpa*, *Udotea*, *Halimeda*, *Penicillus*, *Rhipocephalus*, *Batophora*, *Acetabularia*, *Anadyomene*, a host of red algae varieties that carpeted the substrate in many areas. There were corals, species of the genera *Porites*, *Solenastrea* and *Siderastrea*, gorgonians, sea amenonae, colonial tunicates, an abundance and wide variety of sponges, sea urchins, species of the genera *Diadema* and *Lytechinus*, a number of molluscs, including bay-scallops and pen shells. Most conspicuous, however, were the empty mollusc shells littered about the dens of the stone crabs. Stone crabs (*Menippe mercenaria*) and the spiny lobster (*Panulirus argus*), both valuable commercial species, were abundant where suitable cover prevailed. Also found were sea horses, spider crabs, terebellid worms, and mounds presumably thrown-up by burrowing shrimp.

There was a variety and abundance of the green alga *Caulerpa*. *Caulerpa prolifera*, *C. mexicana*, *C. paspaloides*, *C. sertularioides*, *C. cupressoides*, *C. racemosa*, and *C. ashmeadii* were all found in abundance in the southeast corner of Card Sound. There was C. paspaloides and C. sertularioides throughout Card Sound in abundance.

From the biological population composition, it appears that Card Sound is more marine in character than Biscayne Bay and that it is a more stable habitat physically and chemically -- less prone to extremes. There appears to be greater Thalassia cover in Card Sound as a whole than in south central Biscayne Bay. Although sediment depths are not great, there is sediment of sufficient depth in much of the Card Sound Basin to permit luxurious Thalassia bed development. A report prepared for Florida Power & Light determined sediment depths at 32 stations in Card Sound. Seventeen of these stations, or nearly 50 percent had sediment depths of greater than 25 cm which is suitable for Thalassia growth.

There is a warm turbid layer of water along the bottom of Card Sound -- a thermal inversion -- that exhibited temperatures several degrees above over-lying water masses. The thermal inversion layer varied from 6 to 10 inches to 4 to 6 feet deep. Thermographs off the mouth of Model Land Canal recorded temperature maxima of from 91 to 92°F occurring for several days at a time.

Lee Purkerson

Florida Power & Light Company has proposed a discharge of heated effluent to Card Sound after 100 percent dilution with Biscayne Bay water. A report prepared by the University of Florida, College of Engineering reveals that the introduction of 8500 cfs (5.5 billion gallons per day) of cooling water will significantly elevate water temperature in Card Sound.

The cooling water would be discharged to Card Sound with a temperature increase of at least 6°F above intake levels in Biscayne Bay. An area of 1000 acres would exhibit average summer temperatures of about 94°F and the same area would have temperatures in excess of 98°F, five percent of the time. This represents about seven percent of the total area of Card Sound. If cooling water from the Turkey Point power facility is discharged to Card Sound, as presently proposed by the Florida Power & Light Company, temperatures in excess of 95°F can be expected in at least 35 percent of Card Sound five percent of the time. The biological effects which may be induced in both Biscayne Bay and Card Sound by the salinity and circulation changes which implementation of this proposal would cause have not been evaluated.

Lee Purkerson

At this time, Mr. Chairman, I'd like to show a few slides.

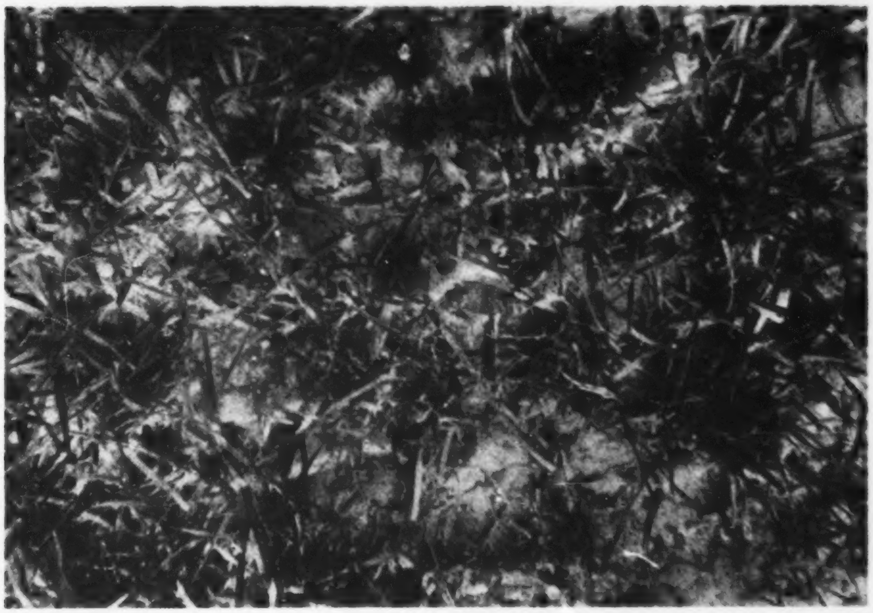
MR. THOMAN: Go right ahead, Lee. These slides are in color. For the purpose of the record I would like to indicate that attempts will be made by Mr. Stein's office in Washington to have them reproduced in color in the conference proceedings. Ordinarily they are reproduced in black and white.

MR. PURKERSON: Slide, please.

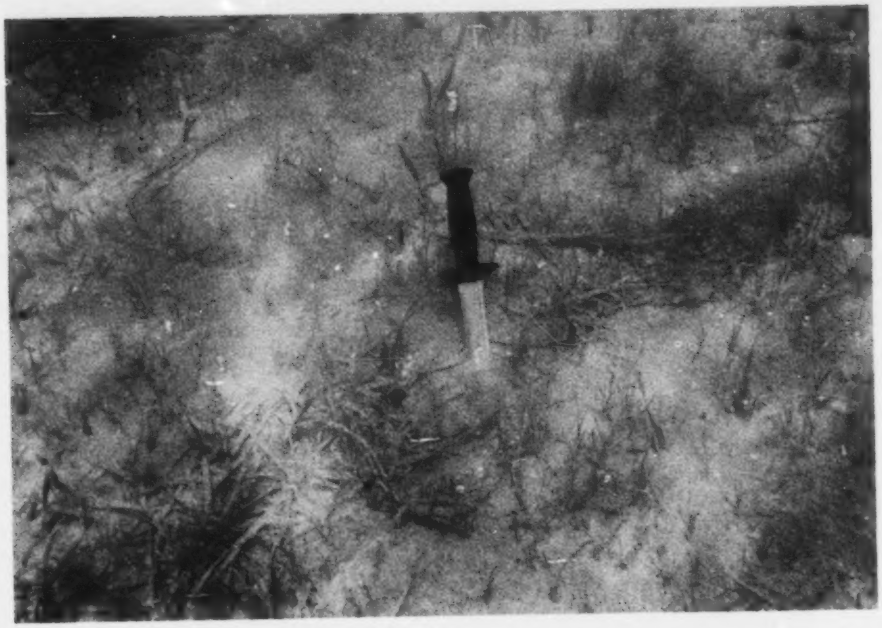
Studies have shown that heat generally flows in a northeasterly direction past the tip of Turkey Point.

Deep organic rich sediments along the shore line of South Biscayne Bay are dominated by lush growths of turtle grass (Thalassia testudinum.)

Although Thalassia is a robust littoral plant able to withstand the extremes of the near shore environment, turtle grass has been found to cast off blades at temperatures in excess of 90°F.



Thalassia in the path of heated effluents arising from Grand Canal, 500 yards from shore, showed definite signs of defoliation during July of 1969.

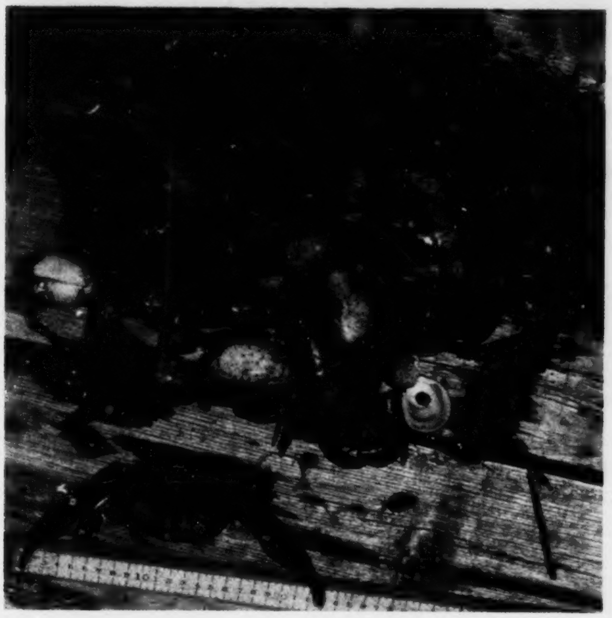


By late September, 1969, at this same site, complete defoliation of Thalassia had occurred.

Aerial photographs taken during mid-June, 1969, reveal that the normal shoreline plant life has been totally destroyed at the mouth of Grand Canal leaving the barren exposed Bay sediments.

Lee Purkerson

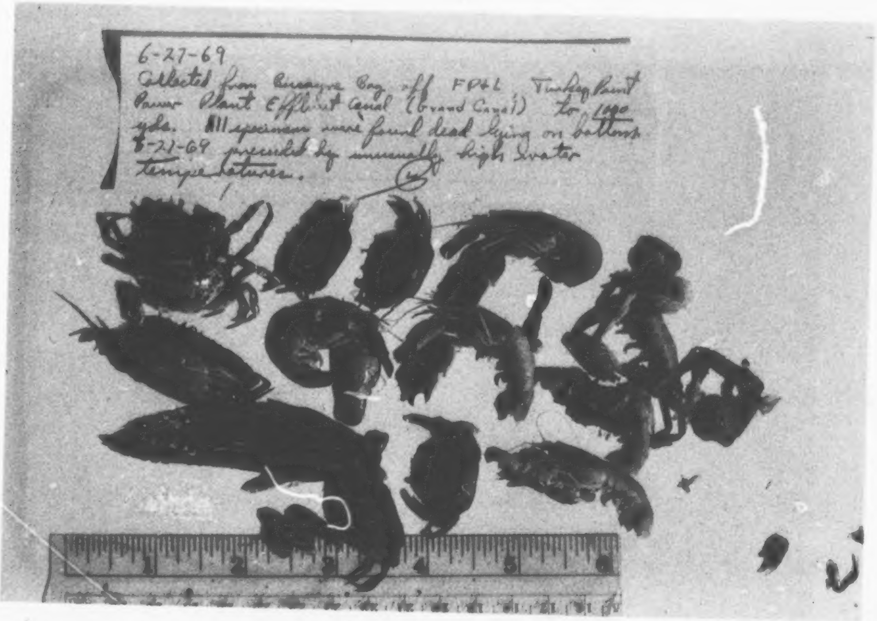
Away from the mouth of Grand Canal, the turbid heated effluent often rides out over the top of cooler bay water. When the heated effluent becomes more dense than the bay water, however, it settles to the bay bottom, there to cause damage to bay bottom dwelling plants and animals. Excessive Bay temperatures recorded on June 25, 1969, by continuous temperature monitors placed near the Bay bottom off the mouth of Grand Canal told of such an occurrence.



Underwater searches were conducted on June 27 and 28, 1969. Beginning at the mouth of Grand Canal, a large number of dead stone crabs were found. Please note the large, dead, dark colored sponge at the top of the picture.

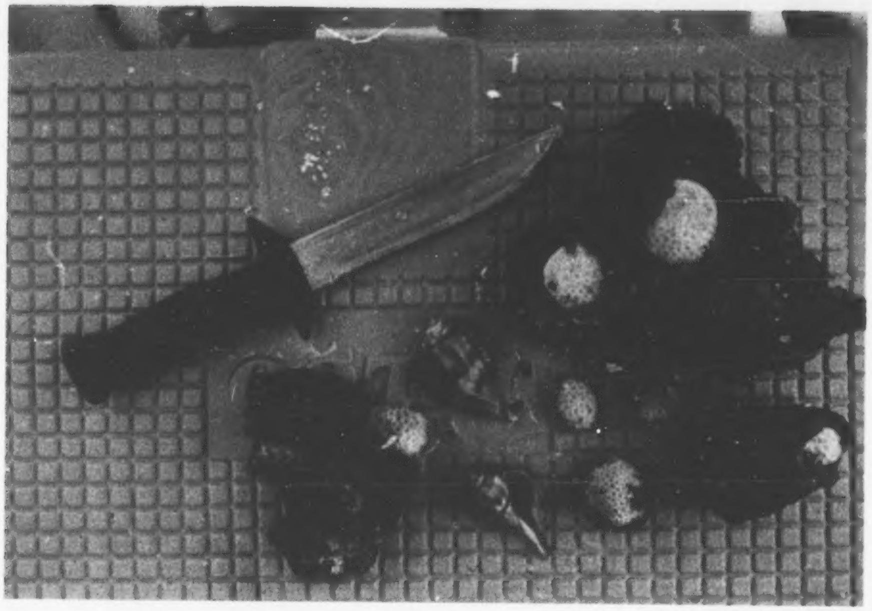
This underwater picture reveals the normal appearance of the same type sponge.

For further comparison, the same sponge out of water following preservation.



6-27-69
Collected from Biscayne Bay off FP&L Turkey Point Power Plant Effluent Canal (Grand Canal) to 1000 yds. All specimens were found dead lying on bottom 6-27-69 preceded by unusually high water temperatures.

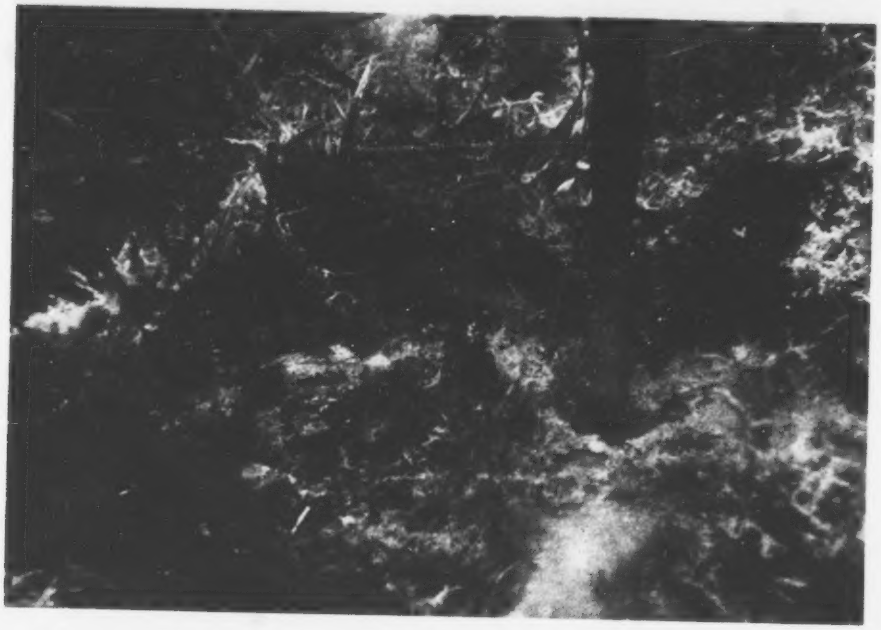
Searching further into the bay, large numbers of dead pistol shrimp, bottom-dwelling fish, spider crabs, blue crabs, small clams, snails, sponges, bay corals, and a wide variety of algae were found.



Bay corals (Siderastrea) and some large whelks (Busycon) found dead 1000 yards south from the mouth of Grand Canal, 500 yards from shore.

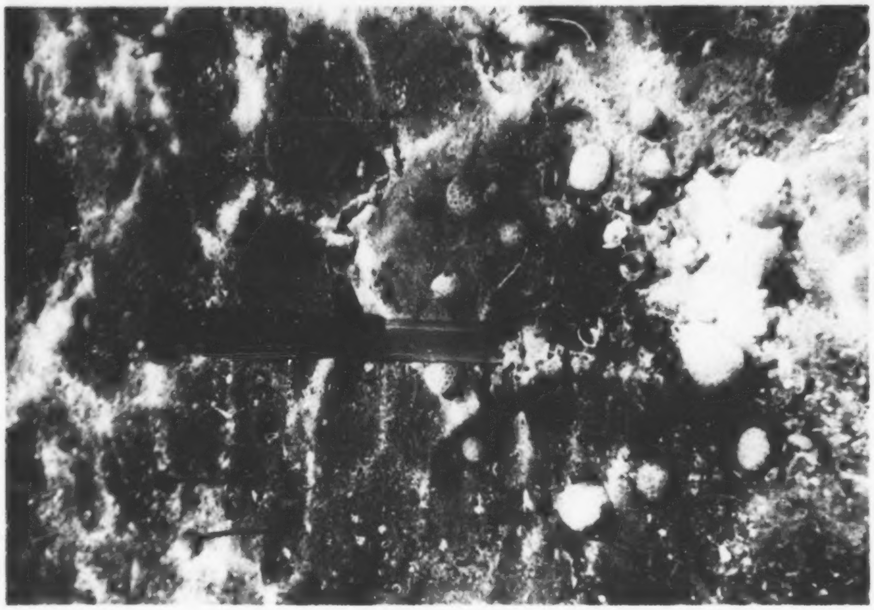
Certain sponges and algae were severely damaged by excessive temperatures, here an underwater picture of a black sponge, to the right a knife, in the early stages of decomposition. Note also the brown color of the usually bright green algae. Anadyomene, in front of the sponge.

Here another sponge of the same type as that shown previously, only in a more advanced stage of decomposition. These sponges were found and photographed at a location 1000 yards east and 500 yards north from the mouth of Grand Canal.

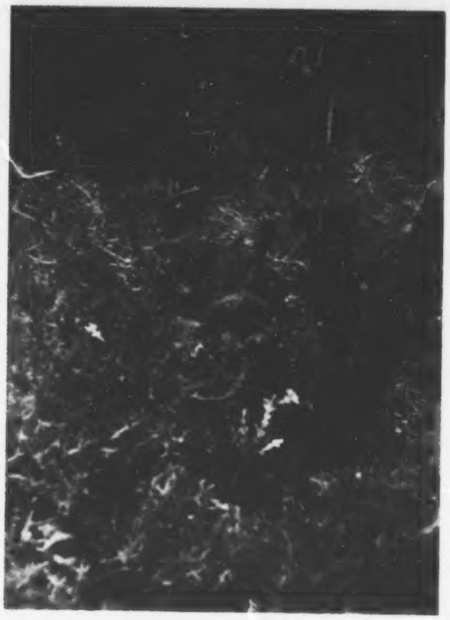


This underwater photograph shows a killed sponge almost totally decomposed. It appears as a pile of ashes to the left of the knife.

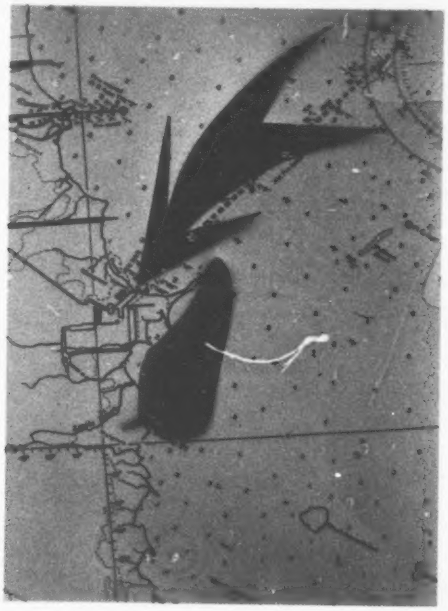
Lee Purkerson



In this picture the red alga mat has been cleared from the Bay bottom to reveal dead invertebrate animals. These were collected from within the cleared area and placed around a killed sponge, in which rests the knife. Killed invertebrates shown include the cross barred venus, *Chione cancellata* (a clam); the worm shell, *Vermicularia spirata*, and Bay corals, species of the genus *Siderastrea*. Note also the brown unhealthy appearance of the green alga *Penicillus* in the upper left corner.



This picture shows sections of bleached calcarious skeleton of the green alga Halimeda. When under stress or when damaged this alga withdraws the chloroplasts leaving the white skeleton. Note the faded red algae and the browning of green algae.



In all 670 acres of Bay bottom demonstrated unquestionably damage by heated effluents discharged from the Turkey Point Powerplant during the summer months of 1969.

MR. PURKERSON: That concludes the slides.

MR. THOMAN: Thank you very much, Mr. Purkerson. We certainly appreciate your very frank testimony.

John, will you proceed?

MR. HAGAN: The Turkey Point powerplant of the Florida Power & Light Company under present operating conditions discharges 1270 cfs or 820 million gallons per day of cooling water at elevated temperatures to Lower Biscayne Bay. Under normal operating conditions, the temperature increase of the cooling water was never less than 3.3°F during the summer of 1969. An increase of 12°F or greater was observed 16 percent of the time under the most conservative present operating conditions, the increase will exceed 10°F at least 16 percent of the time (July 1969.) This cooling water effluent, discharged through Grand Canal, increased temperatures of the receiving water above 90°F at least 10 percent of the time, over an area of 620 acres during August 1969. With the construction and operation of the nuclear powered units, the volume of necessary cooling water will be increased nearly four times to 2.75 billion gallons per day and the waste heat will be 4 times greater than that presently discharged. If this waste heat is discharged to Lower Biscayne Bay, the area of increased temperatures in the bay will be substantially enlarged.

Extensive biological damage to bottom fauna and fish has been observed in the area of increased temperature. The cause of this biological damage to the bay is the waste heat discharge of 1270 cfs from the Florida Power & Light Turkey Point facility. There is no source of artificial organic or chemical pollution which is affecting the water quality of Lower Biscayne Bay. Water quality indicators, other than temperature, demonstrate excellent conditions. Based upon lethal effects only, the biological degradation zone encompassed about 670 acres during the summer of 1969 under the present operating conditions at Turkey Point. This includes no evaluation of the more subtle, long term effects of heat stress upon the biota. When all generating units are in operation, the acute biological damage will occur over a significantly enlarged area for a longer period of time. To prevent further biological damage due to the discharge of cooling water effluent from Florida Power & Light Company's Turkey Point facility, a waste heat control program is urgently required and should be immediately implemented.

John Hagan

The National Technical Advisory Committee in its report to the Secretary of the Interior, April 1, 1968, set strict guidelines for the establishment of temperature criteria. In part, this report states: "All important species, including the most sensitive, must be protected. In the tropics or subtropics, optimum temperatures for many forms are only a few degrees lower than maximum lethal temperatures. Great care should be exercised therefore to prevent harmful increases in maximum summer temperatures in tropical areas."

As a guideline for establishing incremental limits, NTAC recommends the following: "Monthly means of the maximum daily temperatures, recorded at the site in question and before the addition of any heat of artificial origin, should not be raised more than 4°F during the fall, winter and spring (September through May) or by more than 1.5°F during the summer (June through August). The rate of temperature change should not exceed 1°F per hour except when due to natural phenomena. Suggested temperatures are to prevail outside of established mixing zones."

At locations remote from Turkey Point (not closer than 5000 yards from mouth of Grand Canal), the monthly average of daily maximum temperatures in 1968 were: June, 83.1°F; July, 85.6°F; August, 87.2°F. At selected stations in shallow water areas similar to that adjacent to Grand Canal, the monthly average of maximum daily temperature in August was 88.2°F. Following the NTAC recommendations of 1.5°F incremental rise, this would produce a maximum allowable temperature of 89.7°F at the mouth of Grand Canal, a temperature which is now exceeded almost continuously from June through August under present operating conditions.

In a report of the Committee on Inshore and Estuarine Pollution (referred to as the Hoover Committee Report), a group of 10 outstanding scientists in the field of marine ecology recommended, in reference to the Turkey Point plant: "The maximum permissible temperature at the outfall must not exceed 90°F.'

It is recommended that the waste heat generated by the Florida Power & Light Company Turkey Point facility be abated such that the temperature of the receiving waters is not increased more than 1.5°F from June through August nor more than 4.0°F from September through May above the monthly mean of the maximum daily temperature. The Federal Water Pollution Control

Administration, in cooperation with the Florida Department of Air and Water Pollution Control and the Florida Power & Light Company, should establish a temperature monitoring program to determine compliance with the above recommendation.

II. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Severe damage has occurred to the aquatic plant and animal population of Lower Biscayne Bay due to the present heated effluent from the Turkey Point plant of the Florida Power & Light Company.

2. No manmade pollution or any physical condition other than elevated temperature is present which could account for the observed biological damage in Lower Biscayne Bay.

3. Under the most conservative present operating conditions, the temperature rise of the cooling water, across the condensers, will exceed 10°F at least 16 percent of the time.

4. The cooling water effluent discharged from Grand Canal moves in a northeasterly direction around Turkey Point. This path coincides with the zone of biological degradation.

5. The biological degradation zone covers about 670 acres of Lower Biscayne Bay as observed during the summer of 1969.

6. A wide variety of both aquatic plants and animals were killed in late June 1969. This damage to aquatic life and vegetation is directly attributable to the discharge of heated effluent from the Turkey Point facility of Florida Power & Light Company.

7. The monthly mean of the maximum daily temperatures in areas of Lower Biscayne Bay outside the influence of artificially elevated temperatures resulting from waste cooling water is 83°F in June, 85.6°F in July and 87.3°F in August. (1968)

8. The additional operation of 2 nuclear powered generating units at the Turkey Point plant will increase the waste heat load by four times over that presently discharged (without proper thermal control). This increased heat load will intensify the present damage in extent, severity and frequency.

9. If waste heat from the Turkey Point facility is discharged to Card Sound, as presently proposed by the Florida Power & Light Company, temperatures

in excess of 95°F can be expected in at least 35 percent of Card Sound, five percent of the time.

B. Recommendations

1. The Florida Power & Light Company shall abate the excessive waste heat load being discharged from its Turkey Point powerplant to the levels recommended by the National Technical Advisory Committee to the Secretary of the Interior for estuarine waters. The Committee has recommended that the monthly mean of the maximum daily temperatures should not be raised more than 4°F during the fall, winter and spring (September through May) or by more than 1.5°F during the summer (June through August).

2. The Federal Water Pollution Control Administration in cooperation with the State of Florida and the Florida Power & Light Company establish a temperature monitoring program to determine compliance with the recommended temperature requirements as above.

MR. HAGAN: Mr. Chairman, and conferees, that concludes my report.

MR. THOMAN: Thank you very much, Mr. Hagan. Do you have any questions?

MR. STEIN: Are there any comments?

MR. PATTON: No.

MR. STEIN: Although I can't speak for him, Mr. Reed and I did talk about the remarkably good, natural condition of the waters of Biscayne Bay and Card Sound. I believe that this is something that is not too often realized -- that we have some of the best waters in the country right here.

Given the place that they are located, I think these waters match the kind of waters you might expect in such places as Lake Tahoe or Lake Superior. So, I do think we have an obligation to do all we can to see that waters of this type are protected.

Mr. Reed, I indicated that it struck both of us that the quality of the waters in Card Sound and Biscayne Bay are among the highest quality waters we have in the country, and people who work in this field have indicated it, and it behooves us to do everything we can to protect it.

MR. REED: I concur.

MR. STEIN: The next point that I would like to make is this: Do you have any notion when you talk in terms of a $1\frac{1}{2}°$ rise in temperature during summer -- which I guess are critical months, on the basis of your observations -- what a maximum temperature would be recommendationwise?

MR. HAGAN: You are correct in assuming that summer is the critical time. Based on our observations, the observations reported in Appendix 1 of the report and applying the criteria of 1½°F rise above the monthly average of the observed daily maximum which is the NTAC recommendation, we come out with a maximum temperature of 89.7°F. This compares very favorably with the Hoover Committee Report recommendation of 90°F.

MR. STEIN: Thank you. Are there any more comments or questions?

MR. THOMAN: I have a question, Mr. Hagan. Last summer during June, July and August, what was the lowest temperature that did biological damage, or where was biological damage found? In other words, was it at 90°F or something a little higher than that?

MR. HAGAN: The area between 90 and 92°F is rather fuzzy. We know that at 92°F there are lethal effects. We did observe -- Mr. Purkerson did observe -- and conducted examinations and documented that lethal effects in the Bay did occur at 92°F.

MR. STEIN: Again, I'm just probing on this, on the basis of your experience -- let me withdraw that by

-- I don't think, as a regulatory program, we eve [illegible] anything to the limit to get lethal effects. I understood you to say, on the basis of the experience that you have had, if we follow the recommendations of the National Technical Advisory Committee and have a 1½°F rise, then you would get up to about 89.7°F. Is that correct?

MR. HAGAN: That is correct.

MR. STEIN: Now, at that 89.7° do you think that that would be a margin of safety?

MR. HAGAN: It would be a very small margin of safety, but it would be there, yes.

MR. STEIN: In other words, you would think that the National Technical Advisory Committee recommendations are applicable to these waters?

MR. HAGAN: Yes.

MR. STEIN: Thank you.

MR. REED: For clarification, Mr. Hagan, on Page 38, where we got into the water quality standards in the State of Florida, I think that it is important that you mention that the water quality standards of Florida do include reference to a mixing zone. That is not part of the statement on Page 38.

As I look upon the report of the devastation --

of the kill -- over the 670 acres, I look upon this as an indication of a much greater problem to come in 1971 and 1972. Whereas a mixing zone of some size presently shows this damage, we could certainly compute that to a larger zone with the impact of the nuclear units.

MR. HAGAN: We would agree. With the addition of four times the present level of heat discharge, and based on our studies which indicates there is very little mixing of waters in Biscayne Bay, we would suspect that the temperatures would be increased over a wider area, and for a longer period of time.

It may be possible to do a mathematical study or compute this additional area, but it has not been done by us at this time.

MR. REED: Thank you, sir.

MR. STEIN: Any other comments or questions?

MR. THOMAN: Yes, to Mr. Purkerson. Could you come to the podium, please?

Lee, I may not be asking you the right question because I haven't discussed it with you before, but there have been some life forms returning to the area where the kill occurred last June. Is that a correct statement?

MR. PURKERSON: Yes.

John Hagan

MR. THOMAN: Do I read in your report that these are the more tolerant forms that have been returning?

MR. PURKERSON: That and those that have the shortest life cycle are able to reestablish themselves quickly.

MR. THOMAN: Do I also infer correctly from this that some of the very sensitive forms have not come back?

MR. PURKERSON: That's correct.

MR. THOMAN: Thank you.

MR. STEIN: Mr. Hagan, could you come up again?

In terms of gallons, what would the discharge be if Florida Power & Light put both plants into operation? Could you indicate that?

MR. HAGAN: Nuclear plants?

MR. STEIN: Yes.

MR. HAGAN: It would be 4250 cubic feet per second.

MR. STEIN: No, I want it in gallons.

MR. THOMAN: 2.75 billion a day.

MR. HAGAN: Two and three-quarter billion gallons per day.

MR. STEIN: And that either would go into --

as I understand the plans, the alternatives -- into Biscayne Bay or Card Sound?

MR. HAGAN: Those are the two present plans.

MR. STEIN: It seems to me -- you people checked this and you have your biologists here and we are going to get another biologist up pretty soon -- but regardless of the temperature coming up, if you are putting more than 2½ or 2 3/4 billion gallons of water into an area such as Biscayne Bay and Card Sound, that even without any temperature variation you would have a problem. Do you think the bay is going to be the same when it gets the impact of water from the nuclear plants?

MR. HAGAN: It is almost inevitable that as a result of the change in circulation pattern you will get a redistribution of growth within the bay and a change of the ecosystem.

Biscayne Bay is somewhat less saline than Card Sound; therefore, we would expect a change in the salinity regime in Card Sound. We would expect considerable changes in the current patterns in Card Sound and Biscayne Bay as a result of the physical movement of this vast amount of water. From that we can conclude that there would be some changes in the system.

I hate to characterize these changes as damage or as destruction -- outside of an area, say, immediately to the mouth of the canal -- which we would expect as a result of the velocity.

MR. STEIN: Here's the point I am making. If we are talking in terms of that velocity, maybe we have to look for a new term -- "velocity pollution." However, what we have, if we have heard Mr. Purkerson's testimony correctly, is practically ideal aquatic conditions in Card Sound and Biscayne Bay. If we are going to put 2 3/4 billion gallons of water in the bay, and if you are going to say "There is a change," the chances are that we are going to, or maybe -- I'll let you tell me what the changes would be -- you are moving away from these ideal conditions with water of such high quality.

MR. HAGAN: Well, my brief experience in this is that any time you try to change an ideal situation which nature has created, you almost always will have damage. Based on that premise I would say yes, those changes would be detrimental to the body of water of Biscayne Bay.

MR. STEIN: Thank you. Are there any other comments or questions?

MR. REED: Yes, I have a question. I saw a figure someplace in front of me. How old is the geological formation of the bay and the offshore islands from Card Sound?

MR. HAGAN: I'm sorry, I can't answer that.

MR. REED: If memory serves me correctly, I believe some report I have says 3,500 years. It has taken a long time to set up this pattern of circulation. It is easily upset.

MR. THOMAN: Thank you very much, John. I won't promise you a raise, but it is a very fine report.

MR. STEIN: Thank you for a very excellent report.

I am going to say something here again that struck me this morning, and I want to put it out on the table. I think that it should be because some people may come on later who may want to comment on this. That is, we have here a very, very clean body of water -- two clean bodies of water that to all intents and purposes are ideal.

We also have a situation characterized in the Federal report as endangering these conditions or possibly degrading them. Now, I think the characteristic we are faced with -- the type of danger that we are creating for this resource -- is something very peculiar to the modern age. If there is no traditional sewage or industrial waste degrading the water and this report is correct on that, we are dealing with two factors: 1) the fact that a large nuclear powerplant is coming in which may be causing problems by just the mere discharge of the waters that are needed to cool it and the velocity of those waters, plus 2) the heat.

Now, again, this seems to me to be the key. The reason I bring this up, without coming to any conclusions now, is that I think this appears to me to be a new era that we are getting into along with its attendant population growth. While we have had many, many cases before, I think this is the first one that I have been involved in -- and I have been involved in quite a few -- that has dealt with the kind of effects that we can expect from the new atomic age. We have to look at these very, very carefully.

Are there any comments or questions? If not, we will stand recessed for lunch, and will reconvene at 1:30.

(Whereupon the Conference recessed until 1:30 p.m.)

AFTERNOON SESSION

MR. STEIN: May we reconvene? In reconvening, I would like to introduce my boss and the dynamo behind the Federal Water Pollution Control Program, the Honorable Carl Klein, Assistant Secretary for Water Quality and Research.

I would like to modify one statement that I made at the end of this morning's session. When we talked about the new types of pollution that we were dealing with, I should have used the generic term of "power pollution," rather than pollution from atomic plants, because it doesn't matter a bit where the pollution comes from. If the powerplants put out heat or large volumes of water, that is what we have to be concerned with.

With that we will go on with the Federal presentation.

Mr. Thoman.

MR. THOMAN: At this time I'd like to call on a very distinguished member of the professional staff of the Federal Water Pollution Control Administration, Dr. Clarence M. Tarzwell, who is the Director of the National Marine Water Quality Laboratory in West Kingston, Rhode Island. Dr. Tarzwell is an internationally known biologist. He has been a good friend of mine for quite a number of years.

Without further ado, Clarence.

DR. CLARENCE M. TARZWELL, DIRECTOR,
NATIONAL MARINE WATER QUALITY LABORATORY,
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION,
WEST KINGSTON, RHODE ISLAND

DR. TARZWELL: Mr. Chairman, conferees, ladies and gentlemen, this afternoon I plan to discuss some basic principles of temperature effects and temperature requirements; then I will briefly discuss the recommendations of the National Technical Advisory Committee.

In introducing me, Mr. Thoman has said that I am the Director of the National Marine Water Quality Laboratory. I also served as Chairman of the Committee of the National Technical Advisory Subcommittee which had to do with the recommendations of water quality requirements for fish, other aquatic life, and wildlife.

In this task, of course, we had to consider many basic problems, approaches, the effects of temperature, and how it perhaps should be protected from or handled so that it did not damage desired water uses.

Now, temperature is one of the most important, if not the most important single factor influencing the qualitative and quantitative make-up of aquatic populations. However, you noticed I said "single factor." We cannot consider temperature alone. It must be considered with other environmental factors which influence the biota.

We must specially consider temperature and oxygen levels together because in the aquatic environment we are dealing with cold-blooded organisms whose metabolism is dependent, largely dependent upon the surrounding temperature; therefore, as the temperature goes up, their requirements for oxygen also increase.

On the other side, of course, as the temperature goes up, the water will hold less oxygen, and it has less when you really require more.

Furthermore, we must also consider salinity, pH. The more saline waters, of course will hold less oxygen, but the basic thing is the temperature-oxygen relationship for supplying metabolism. If you raise the temperature high enough you will reach an area where there is no scope for activity. An organism can take in just so much oxygen from water. As the temperature rises, a point is reached where all the oxygen is required for metabolism, and there is none left for activity. The organism carries on only the basic metabolism, and then when the temperature rises slightly you get to a point where the organism cannot support metabolism and, of course, death results.

For normal development there must be some scope for activity. In other words, you can't have just enough oxygen so that the organism can exist; you need enough to allow for a scope of activity.

Carbon dioxide, as well as other dissolved materials and trace elements, is a nutrient and light is also important, especially for the aquatic plants. It should be realized that if you raise the temperature you must have more oxygen, or if you raise the temperature other environmental factors must be more favorable; and also that when you raise the temperature, toxicants act much more rapidly.

So if you're going to add toxicants later on, it means that the safe levels for toxicants must be lowered.

Dr. Clarence M. Tarzwell

Temperature affects aquatic organisms in a number of ways. It may affect them directly; that is, there could be direct lethal effects, or there may be sublethal effects; in other words, stress. It may reduce the ability to swim, to grow, to reporduce, or to produce a crop. These sublethal effects are more subtle.

Of course, we have the indirect effects such as disease and predators. Generally, when you raise the temperature disease and predators become more troublesome. There is also in many areas the question of competitors and predators. Very often with higher temperatures the predators and competitors become more important and the desired species do not do so well.

I would like to say a few brief words about the subtle effects of unfavorable temperature, some of which may be physiological. Temperature influences enzymes, and sometimes above certain levels some are inactive or not produced. It affects the development of the gonads, the preparation of the organism for reproduction, and at certain temperatures they don't develop normally, or they are inhibited from developing.

The development of the sex products, of course, takes place in the seasonal cycle that the organisms go through. Generally, temperatures trigger spawning, and they influence the laying of eggs and the development of the eggs and larvae. If temperatures are unfavorable the eggs may not hatch. Temperature also triggers the migration time in those that migrate for spawning.

Temperature can have a genetic effect. I will give one example. If you have ever had anything to do with raising of Daphne you know when it starts to get cold in the fall they have sexual reproduction and produce their winter eggs. In other words, this is a real genetic effect because it influences the type of eggs and the type of reproduction. Temperature can effect productivity. With a certain rise in temperature productivity may increase but beyond a certain level growth stops and then drops off.

Temperature also affects longevity, especially among the temperate forms that have moved farther south. In the northern part of the country the large mouth bass and small mouth bass attain an age of 8, 10, 12 or more years. However, in Alabama I never found bass over four years old. In the south they grow faster, but they don't live as long. This is quite typical.

Dr. Clarence M. Tarzwell

Now, I would like to discuss briefly temperature requirements. First, there are two outstanding things that people seem to forget, and they are that we must have seasonal variations in temperature, and that we must have diurnal variations in temperature. The aquatic populations that we now have are the product of a long evolution. They had to adapt to certain conditions, and those that didn't adapt are gone. The populations that we have now are residual populations which are the product of long periods of evolution.

In this process, through geological time the environmental requirements to which the aquatic populations become adapted have now become their environmental requirements, and since the requirements are arrived at through a long period of time, you cannot rapidly change them without getting into serious trouble.

These populations are used to seasonal variations, and metabolic activities have a seasonal rhythm which is correlated with seasonal change. These seasonal changes are required for the development of the sex products, the gonads, and they are required for preparing the animal for his annual life cycle, for his spawning and for his migration.

Dr. Clarence M. Tarzwell

A constant temperature is not suitable; is not the way that they have lived. They cannot stand constant high temperatures. Many people make mistakes in regard to temperature suitable for aquatic life. They go out and find organisms at high temperature and they say, "What's the matter with you? You're setting your standards or requirements too high because here they are living at a higher temperature."

I would like to point out that high temperatures at which they can survive very readily in the summer would kill them very rapidly in the winter if they should suddenly be exposed to them at that time; and low temperatures which they can stand in the winter would very rapidly kill them in the summertime when they are acclimated to higher temperatures.

When you acclimate species to a higher temperature and then raise the temperature to a higher level at which they can live, you also raise the lower lethal temperature; so when you acclimate organisms to higher temperatures and expose them to higher temperatures over long periods of time, you also raise the lower temperature which becomes lethal if the temperature drops.

Winter kills are quite common as well as summer kills, and we have both types of natural kills nationally and over the world.

Temperatures determine breeding time. The food of many organisms are plants. The spawning time of animals and the development of eggs are determined by the accumulation of temperature days before the raising of the temperature speeds up the seasonal development, and they spawn. Now, if the temperature is raised you may have them spawning early in some areas before their food is there, because very often the food of the larvae and young of these animals is phytoplankton, and it is dependent not only on temperature but on light, even more on light than temperature; so it may not be developed. Sometimes you can have some forms coming out and hatching before their food is available.

Higher temperatures can initiate or block migration, spawning and the development of the young. If it gets too high, it will block spawning activities and prevent spawning.

At unusually high temperatures at which organisms can readily live the temperature may be so high that it prevents spawning. Such an instance has been reported in England where temperatures were raised, and barnacles didn't spawn. The water temperature has to be lowered below 50°F before they will spawn.

Winter temperatures are very important. We must have this cooling-off period and have this seasonal variation for most species.

Now, as to daily variation or diurnal temperature change. These are essential because this is the condition to which the organisms have been accustomed. If you keep organisms at one constant high temperature, such temperatures at which they can survive are not as high as the peak temperature at which they survive if they are briefly exposed for a few hours with the temperature going down at night. In other words the organisms can stand high temperatures for short periods which would kill them if you exposed them continuously. Therefore, when individuals observe some organisms at the hot time of the day living at high temperatures they say, "Look, they are living very well at that temperature."

This is misleading and incorrect. I would like to point out and stress that temperatures at which adults can live, and at which they may grow and seem to thrive are no measure of the temperatures required for the survival of the species.

Dr. Clarence M. Tarzwell

For reporduction and the development of the young very often narrow temperature ranges are required and usually it is lower temperatures that are required.

Recently we have been doing some work with the winter flounder. We raised the winter temperature a certain amount and found this inhibited development of the sex products even though it was not a large increase in temperature. Those experiments are still under way.

This ability of aquatic animals to withstand higher temperatures for short periods or to seek out higher temperatures in winter, which they do, seems to lead many people astray. It is a well known fact that fish during the wintertime like to seek out and go into water of higher than normal winter temperatures. They congregate there. Both the marine and freshwater organisms do this.

In a lake in Oklahoma one winter fisherman took almost half the total fish catch out of a three acre area because it was heated during the winter and the fish congregated in the heated area. But I want to point out the fish were not produced there. They came in from other areas, and they had to be recruited from other areas.

Dr. Clarence M. Tarzwell

This also occurred on the Delaware River where heated water was released from a powerplant. Fish congregated there in winter but they left in summertime when temperatures exceeded 85°F. So if you see good fishing, or you see a certain growth in winter when the temperatures are low, that doesn't mean that fishing is going to be good at other seasons or that fish are going to grow there the year round. Very generally it does not. If temperatures are raised above a certain level in summer there's not going to be very much there except the most resistant species, and this is in itself not too good. If you have species that are sensitive and you put something in that stresses them, you eliminate these most sensitive species and end up with the most resistant, and they may become a nuisance.

This is a basic reason for undesirable algal blooms. This is why you get your nuisance growth in many areas where you have had pollution. When you eliminate the more sensitive species your most resistant species can become nuisance organisms. Just because you find resistant species in an area doesn't mean that the environment is good. It means that when sensitive species are eliminated and all nutrients become available for resistant species they become undesirable and become a nuisance.

The hardest thing to get across seems to be an understanding that these high temperatures which can be withstood a short time cannot be withstood for long periods and you must have diurnal variation, and for good production you must have temperature well below those that can be survived for short periods.

MR. PATTON: How low?

DR. TARZWELL: Well, reproduction is generally in rather narrow limits. The temperatures that are favorable are much narrower than those that the species may live in throughout its life history, both the development of the eggs and generally the development of the young.

Now, there are some exceptions to this where the young can stand a little higher temperatures, but it goes back to the evolutionary development. If the young developed generally in areas of high temperature, of course, with the adults out farther, you find in that instance that the young can withstand higher temperatures, and the temperatures required for each of the developmental stages goes back to the evolution cycle. What conditions did they evolve under?

Dr. Clarence M. Tarzwell

Now, I would like to speak about some special conditions in marine environment. The marine environment does not fluctuate as widely as the freshwater environment; and the organisms there have become adapted to a narrower range of environmental conditions; therefore, they can't stand the wider range that we are used to in the freshwater.

Furthermore, in the tropics they are limited even to a more narrow range more so than the marine species in the temperate areas of the country.

In determining the favorable or allowable conditions for marine organisms, we wouldn't consider the conditions under which the intratidal organisms live. If you have been in a shore area when the tide is out, and you have noticed the oysters out of water with the sun beating down on them, you realize that if they can stand that heat the temperatures they can withstand are no measure of what is required from the standpoint of temperature below the tidal zone, and out into the deeper water, and especially for the benthic or bottom organisms, thus the peak temperatures observed in the intratidal zone are no measure of what is required for the production of a crop of our most important marine organisms.

Dr. Clarence M. Tarzwell

In the intertidal areas, and especially in tropical areas the water becomes very warm at times. Temperatures go way up. Animals living in the intertidal zone, of course, can stand high temperatures. We have algae in hot springs, but they are not the kind that is at the base of the food chain in the marine environment.

In protecting resources and in promoting the production of fish in any body of water, we must protect the most sensitive important species. This is basic. If this is not done you cannot have a balanced condition. If you don't maintain the balance of nature, you get only the residual most tolerant forms. You can get some pretty bad conditions and even nuisance conditions. I think this has been very thoroughly demonstrated over the country. In other words, a balanced population is essential.

Now, a little bit more about some tropical conditions. Environmental requirements vary in the tropics with the organisms and their life stage. A cool winter period is essential for good development of some organisms; for instance, with the sea urchin, the cooler the water gets in this area, the better reproduction they get. The gonads develop more fully. It is desirable to have winter water temperature down to 70° or even lower.

Dr. Clarence M. Tarzwell

From what I have learned in talking with biologists who have studied tropical organisms, and from what I have learned in reading the literature, it seems that summer temperatures should be a little below 90° in order to be favorable.

You can stress some species at temperatures below 90°F. With the larvae of some fish some stress starts at 86°, and as you progress it becomes more important. Of course, if these species developed in the spring when the temperatures are naturally lower, you don't have that unless they are artificially raised at that time. It is the temperature that occurs in the spring or at the time of larval development, of course, that's going to affect them.

The estuaries are the nursery areas. It is here that many of the young are produced. The young of many of our important species, the greater majority of them, I think it is conceded, have their development, or at least a portion of it, in the estuaries. They are the nursery areas for many of our sport and commercial species. There is also some good fishing in the estuaries, but you don't have to expect that you are going to catch all of your marine fish there.

Dr. Clarence M. Tarzwell

Many of the species that use the estuaries as nursery areas spend their adult life out in the open ocean. So it is not the area that's all important from the standpoint of yield. However, I think that if you have a family you know you have to protect your nursery, and the nursery area is one of the most important areas in the house. It is also the most important area from the standpoint of our marine fishes, and it must be protected if we are going to continue to have our aquatic resources and the source of protein food that's so valuable to us and also as a source of minerals and vitamins and for recreation and the enjoyment that people seem to have around water areas.

It seems from what I can learn from others and from what reading I have done, you start to get very serious stress for most organisms when you get above 92°F. This probably should be about the top temperature if you're going to maintain environmental conditions which are favorable for the production of a crop.

The National Technical Advisory Committee discussed all of these questions. You heard some of our recommendations this morning, and you know what they were. I don't have to repeat them, but I would like to read a few statements from the report of the committee. I have expressed these requirements in one way but I'd like to emphasize them by reading a portion of the Committee's statement.

"Temperature requirements of marine and estuarine organisms in the biota of a given region may vary widely. Therefore, if we are to maintain temperatures favorable to the biota, all important species, including the most sensitive must be protected. It has been found that organisms in the intertidal zone vary considerably in their ability to withstand high temperatures. Those in the uppermost area of the tidal zone generally can withstand higher temperatures than those in the lower portions of the tidal zone and those in turn generally can withstand higher temperatures than the same species of animals living in the subtidal zone.

"In our marine waters there is a great mixture of species. Species typical of higher latitudes are found with species that are more abundant farther south. In some instances a rise in winter temperatures of only 2^0 to 3°F might be sufficient to prevent spawning and has eliminated the species from the biota.

"When you get in the tropics, it is a little different than it is in the temperate area, but you still have to have these lower winter temperatures. Marine tropical fishes because of various ranges of environmental conditions in tropical water are less tolerant of temperature variations. They can accommodate somewhat. but overall temperature range and rate of change are even more important than they are in freshwater, and, of course, their tolerance in the opposition is even less.

"Spawning and development frequently occur at lower temperatures and the sexual products ripen on rising temperatures after a period of low temperature.

"There are instances where a change in the currents with a resulting increase of water temperature has resulted in fish kills. There have been natural fish kills, and an organism acclimated in one area might be killed if he were put into another area. If an animal is acclimated to a high temperature then his lethal low temperature is correspondingly caused. As an example of the effect of a rapid change in temperature, it has been found that a drop in temperature from 58° to 43° kills sardines. Tolerance of minimum temperature vary with the population. As an example, on the Texas coast there were kills of a certain species at minimum temperature whereas the same species was killed off of Bermuda with a drop to 59°, which is 19° higher than the total coast minimum. Many kills have occurred in nature due to unusually low temperatures.

"This demonstrates that you must look into local conditions. Tropical environmental conditions are somewhat unique in that they have a narrow range, and the fish and other organisms in these tropical waters are living regularly at temperatures that are only a few degrees below their lethal temperatures."

The recommendations of the National Technical Advisory Commission have been summarized. These state that in the summer months, June, July and August, the monthly average of the daily maximum temperature should not be raised more than 1.5°F.

After looking into the conditions down here and examining the September temperatures, I think that the committee should have included September as a summer month with those other three months for these tropical conditions such as occur here in the extreme Southeast Florida.

When we were working on the temperature problem and trying to recommend temperature requirements, the desire was to have us make a recommendation that would apply nationwide. However, there are variations in every area and these local conditions must be taken into consideration. This is why we took the monthly average of the daily maximum temperature as a base. In doing this we take into consideration the local conditions, and then we add on a certain temperature, an increase which to the best of our knowledge, our studies, our investigations and our experience we judge to be allowable.

However, due to our subsequent findings, I'm a little bit afraid that we have been too liberal when we suggested a rise of 1.5°F and we may have exceeded favorable or allowable levels with this and the four degree recommendation.

In Charleston Pond, Rhode Island, in an estuary on the south coast, we took continuous temperature records during 1968. In July of that year we had two very hot days. At that time, the temperature rose 2° above the monthly average of the daily maximum and we had a fish kill.

This rise is even less than would be allowed if the monthly average of the daily maximum temperature were to be raised 1.5°F because if there is a daily fluctuation of 4°F, water temperature would go at least 2° beyond the new monthly average of the daily maximum temperature. However, the reason of only 2°F killed the winter flounder. It is apparent that the recommended 1.5°F increase in the monthly average of the daily maximum temperature for the summer months is liberal but may be about right. I think the committee has done the best it could under the circumstances. In addition we stated very clearly that if research data taken at a later time should indicate changes in our recommendations that they should be made.

It would seem, therefore, that we should accept the recommended 1½° increase of the monthly mean of the daily maximum during the months of June, July and August, and the 4° during the other period. However, there is nothing said about maximum allowable temperatures and this was the one defect of our recommendation.

All we are speaking of is an average, and it doesn't tell the upper limit. From the literature that I have been able to examine and what I have been able to learn from other workers, it would seem that 92°F should be the peak temperature in the Biscayne Bay area if we are to prevent a very serious harmful effect. It should be realized, however, that this temperature may be lethal for some organisms.

In regard to the proposed powerplant, and the release of the cooling water, I think that there are some very important things to be considered. This plant is large. I'm told that the flow-through for cooling at peak production is going to be 4,250 cubic feet per second. That's a great deal of water, and we should carefully consider what such a use means.

Water for the proposed plant is to be taken from lower Biscayne Bay, which has been reported to have an area of 100 square miles with an average depth of seven feet. At a pumping rate of 4,550 cfs the whole 100 square miles of water to a depth of seven feet would be passed through the cooling apparatus in 53.72 days.

If we take the area of Card Sound, 14,200 acres, with this same discharge coming into Card Sound, the volume of water contained in the sound will be displaced in 16.8 days.

It is my understanding that the Florida Power & Light plans to pump 150 percent extra water to mix with the water from the condenser to lower its temperature to 95°F.

Dr. Clarence M. Tarzwell

Thus there will be a pumpage of 10,625 cubic feet per second at times of peak temperature. When this volume of water is pumped by the plant a volume equal to 100 square miles in area and an average depth of 7 feet will be passed through 21.2 days, and it would displace the water in Card Sound in 6.73 days.

Data collected to date indicate peak ambient natural temperature of about 87°F in the open water areas. Temperatures in the intertidal zone are often much higher reaching 104°F or more. Average temperature increases when the water passes through the plant have been estimated to be 14.8° to 16.8°F. Even greater increases have been observed at the existing plant. Also there are daily or diurnal variations in the temperature.

With this great use of water it is evident that there will be a change on the currents of Biscayne Bay and Card Sound. At the predicted usage of water and the calculated time of exchange of water in Biscayne Bay and Card Sound, it is evident that the planktonic forms of the estuary will pass through the plant. Studies we have made indicate that most of the organisms which pass through the condenser are killed. In determining these kills great care is needed to distinguish the dead from the living organisms. You hold the samples for a while to determine those which are dead and settle out and those which are alive and reproduce. We find a large percentage are killed.

As stated previously at the announced rate of pumping the water in the 100 square miles of lower Biscayne Bay will be pumped and passed through the canal in 21.2 days.

At this rate of flow the volume of Card Sound would be displaced in 6.73 days. This is a very rapid exchange of water. The plankton organisms will be taken in with the water. As stated previously, a large percentage of the plankton population is killed by passage through the condenser. In addition, especially in this area, the larvae of the mollusk (clams, mussels, scallops and oysters), the worms and the arthropods are taken in along with the phytoplankton and zooplankton organisms. The larvae of fish which are present in the water will also be taken into the canal and exposed to the high temperatures.

Because the water with its contained organisms which are taken from Biscayne Bay are discharged through a long ditch down to Card Sound, the contained organisms are exposed to the elevated temperature for a much longer period than they are when passing through the condenser. If the temperature of the effluent water is to be 95°F the additional exposure to this higher temperature will result in an even greater kill.

When the effluent water enters Card Sound there will be a drop in velocity and the suspended dead organisms will be deposited. Because high volumes of water will flow through the canal, the dead organisms will represent a large volume of organic matter. This could be quite accurately calculated, but it is evident that the total mass will be measured in tons. These dead organisms may well produce a BOD problem. The killing of the phytoplankton, zooplankton, the larvae of the benthic invertebrates and the larvae of fishes, due to heating in the condensers or in the effluent canal, will destroy the productivity of Biscayne Bay and its value as a nursery area. We are facing serious problems here. We do want and need electricity, and people are demanding it.

I have thought about this problem and I have some personal opinions. I don't know how others feel, but as I look over the situation it seems to me that these larger plants should be out on the coast where they can discharge to the open ocean. With this approach some of the open ocean areas will be damaged. But, area for area, the open ocean area is not as important or valuable as the estuaries, which are the nurseries for the important game and commercial species.

We must take care of the nurseries. Even if we must sacrifice some of the open ocean areas due to the large amount of excess heat which must be discharged, it is considered best to take the damage in the open ocean rather than in the estuaries. We must do all we can to utilize waste heat and abate heat pollution. Questions of heat pollution and the abatement of such pollution are problems which must be faced by the American public.

I think the most important problems facing us today are environmental management and population control.

We don't know all the answers. We do know some things that we shouldn't do. We have made recommendations to that effect. I am trying to present some basic questions for consideration so perhaps we will be better fitted as citizens to face up to this problem, to know what has to be done, and if necessary to pay more for our electricity.

MR. STEIN: Thank you. Any comments or questions?

Mr. Patton.

MR. PATTON: Doctor, you apparently feel this area is one of the most critical as far as temperature is concerned because of its subtropical nature?

DR. TARZWELL: Yes, sir.

MR. PATTON: And this portion of Florida is the most critical in that regard?

DR. TARZWELL: This is considered a tropical area from the standpoint of aquatic life -- the land area is subtropical, but south of a line from Fort Lauderdale to Fort Myers, the biota is tropical. It has a large number of Caribbean species.

MR. PATTON: But it is living closer to the lethal limits?

DR. TARZWELL: Yes, sir, to the upper lethal temperature limit.

MR. PATTON: As I recall, you made a statement -- I'm not sure of your precise words -- that you would not have as much difficulty if you have a fluctuation with the heating effect for a few hours.

DR. TARZWELL: Well, what I was getting at was the need for diurnal variation. The highest constant temperature which can be tolerated without undue stress is not as high as peak temperatures of short duration in the diurnal cycle where there are significantly lower temperatures at night. What I want to stress also is that peak daily temperatures of short duration are no measure of safe or allowable temperatures for constant exposure. In recommending requirements and allowable peak temperatures we state that these peak temperatures must be of short duration and that diurnal and seasonal variations must be below these. Many people have seized on these peak temperatures, however, and take the position they are safe around the clock day after day. They are not.

We know that the biota can't stand these peak temperatures round-the-clock, day after day.

MR. PATTON: You indicated, as I recall, that the flow could displace the entire volume in lower Biscayne Bay in something like 16 to 17 days.

DR. TARZWELL: With 150 percent increase in pumping above the volume passed through the condensers it would take 21 and a fraction days for the water contained in this 100 square mile area to be put through the pumps. Of course, all the water in this area is not going through the pumps because currents will be set up.

What I am saying is that the volume that is contained in a 100 mile area having an average depth of 7 feet would go through in that length of time.

MR. PATTON: What effect, in your opinion, would this have on the character of lower Biscayne Bay if you continued to flush it out of Biscayne Bay and on down into Card Sound?

DR. TARZWELL: All I can do is give an opinion at this time. But since the estuaries are the nurseries areas and the young are there and not in the open ocean, when you start pumping that much water out of South Biscayne Bay and bringing in open ocean water and do it constantly, it is evident that most of the planktonic organisms will be removed and might run into some pretty serious trouble.

MR. PATTON: What would you expect the effect to be on Card Sound receiving this volume?

DR. TARZWELL: Passing this water through there so fast would alter the environment. In passing through the ditch down to Card Sound the water has been estimated to cool 0.5 to 1°F. However with a temperature of 95° in the ditch, when you have it all mixed, it wouldn't cool very rapidly and the temperature of Card Sound will be raised. I couldn't say how rapidly it would cool; but with such a rapid exchange of water in Card Sound I think you would have more or less sterile water coming in there, and with the rapid exchange I would think that it would be logical to conclude that productivity would take a nose dive.

MR. PATTON: Do you think the lower forms of the larvae would survive this?

DR. TARZWELL: Since you would be putting a portion of the volume through the condensers and exposing the suspended plankton forms and larval fishes to high temperatures and since the organisms in the total volume pumped would be exposed for a considerable time to the high temperatures in the ditch, the mortality would be high. Especially damaging would be the killing of larvae of the worms, mollasks, fishes and crustaceans. Phyto and zooplankton generally have a short life history and they could recover more rapidly. The dead organisms which settle out might act as a fertilizer to stimulate their regrowth. On the other hand, these dead organisms might create an adverse BOD effect with the lowering of dissolved oxygen.

I can't say how much this would be with the proper studies of the amount of plankton per unit of volume, and the percentage killed, the weight of the dead organisms could be calculated and the BOD estimated.

MR. PATTON: Thank you.

MR. THOMAN: Dr. Tarzwell, you mentioned something about the life forms dying above 92°F. Some of our work last summer indicated that death did occur at 92°F. Are you suggesting that this might be the maximum allowable temperature without regard to marine safety factors?

DR. TARZWELL: From what I have learned from discussions with workers in the field and an examination of the literature, 92°F seems to be the critical temperature for the important organisms. They are stressed at that temperature and many die. Some organisms are stressed at temperatures below 92°F. Many species die at temperatures between 92° and 95°F. There are some that can survive temperatures of 95°F.

But what I am saying is that there would be so many that would be killed that you would be selecting for only the most resistent and tolerant forms and if they were the only ones left all the fertility would be available to them and undesirable growths or blooms could result.

Let me give you an example in freshwater. Lake Erie has been spoken of as a dead lake. But, probably from the standpoint of pounds, it is producing more living organisms than it did before, but they are not the kind that people want.

Undesirable blooms are produced which create nuisance conditions and odors. The desirable fishes are gone; the appearance of the water is undesirable; and algal growth interferes with swimming and collects on beaches. Fishes left are carp, gizzard, shad and alewives. In this area, high water temperatures could kill desirable organisms and encourage the growth of such forms as bluegreen algae.

MR. THOMAN: I understand what you're driving at. We are now measuring pounds productivity against pounds of productivity in two different senses. But what I'm trying to elicit from you is what maximum temperature you feel, if any, should be permitted, or what maximum degree increase over ambient, or background temperature, should be permitted.

DR. TARZWELL: For the present, I would recommend that the allowable temperature increase should be what has been recommended by the National Technical Advisory Committee, namely: an increase of 1.5°F of the monthly average of the maximum daily temperature for the summer months and 4°F for the other seasons. I believe that September should be considered as a summer month. Because we are dealing with averages, we must designate a peak allowable temperature. This peak allowable temperature for the hottest month should be 92°F.

Eventually we should set peak temperatures for each month of the year. Without these peak temperatures, averages could be met with peak temperatures so high that most species would be killed.

From the standpoint of the survival of a species or the survival of a biota, averages don't mean very much at all unless you tell what the extremes are. It is the extremes that are limiting and you only have to kill an organism once and a high temperature of short duration that kills could wipe out a biota just as effectively as one of long duration. This is why we are going to have to have peak temperatures specified.

MR. THOMAN: In other words, what you're saying is that the absolute ultimate maximum temperature that occurs at any one instantaneous time can never exceed 92°, but --

DR. TARZWELL: But you're going to --

MR. THOMAN: Let me go on. But that the 1½°F rise over the ambient temperature measured as a monthly mean of the maximum daily temperatures should still hold?

DR. TARZWELL: Yes, sir. As it was stated this morning with normal ambient temperatures here in August, which is the hottest month -- this would give a maximum temperature of about 89.7° or 89.8° and the maximum allowable temperature is over two degrees above that.

I'm not saying that everything is going to die at 92°. Don't misunderstand me. From the standpoint of the production of a crop the peak temperature should not be exceeded. This conclusion is based on present data. You're going to have other organisms, some of which are going to live at 95°F; but most will be killed at 95°F.

From the standpoint of productivity, which is what you want this seems to be the best figure that we have at the present time.

MR. STEIN: Dr. Tarzwell, let's see if I understand you. You mean that you can possibly have 92°F for a couple of hours here and there, but not as a regular operation?

DR. TARZWELL: I would look on that 92°F as the peak temperature that would occur for only a short period on those critical days in the year, or in the month of August, which would be most critical.

MR. STEIN: How long is that?

DR. TARZWELL: I believe the peak temperature should prevail for only short periods. We cannot say definitely what the effect of temperatures in the range of 90° to 92°F would be, but I believe it would be harmful. I have had more experience in freshwater. If I were dealing with freshwater organisms, I would say six to eight hours, but remember now this peak is only for that month.

MR. STEIN: I understand that. In other words, if you are shooting for 90°F as was elicited before, perhaps

89.7° or 89.8° you could expect on a few real hot days to get 92°, and you figure, possibly, that is what it can stand, but when you're talking about 92° you are not talking about 92° as a limit for a regulatory group to work on?

DR. TARZWELL: No.

MR. STEIN: We cannot go up to 92 all the time?

DR. TARZWELL: No.

MR. STEIN: This is just the occasional thing on a hot day.

DR. TARZWELL: Yes. Furthermore, I'm not speaking about 92°F for all summer or the year around. This peak temperature is only for the hottest month. The peak allowable temperatures for other months of the year are going to be correspondingly lower.

MR. STEIN: Let's zero in on this. Let us suppose -- and I looked at this -- that if you get a maximum peak plus that 1½°F rise, and this would bring the temperature up, say, pretty close to 90° -- bring it up to 90° -- you may run up to 92° for six hours a couple of days in August. The point is, if you brought it up to 92° all the time, you would be in trouble?

DR. TARZWELL: You would be in trouble. You would be very much in trouble.

MR. STEIN: Let me ask you this question. You claim, as I see it, that the standards of the National Technical Advisory Committee are pretty well limited. You said 1½° in Florida for all waters, with a few degrees below lethal temperature, this is the critical point in your national committee recommendation, is it not? If you went above 1½° in these kinds of tropical waters, we have less leeway, don't we?

DR. TARZWELL: We certainly do. If we had known more about this we probably would have been a little more cagey at that 1½°, to be frank.

MR. STEIN: In other words, you would consider that 1½° the maximum limit?

DR. TARZWELL: I feel that that is liberal, yes, sir.

MR. STEIN: Let me get to another point. The recommendation here says that during the winter months they can have up to 4°. They define the winter months as September through May. Your recommendation is that we knock out September and put that in the summer months?

DR. TARZWELL: Yes. When you add the 4° in September, you are up over 90°.

MR. STEIN: By the way, I don't mean to be specious, but I have known Dr. Tarzwell conservatively for about a quarter of a century, and, as I say, for the record, I am perfectly aware that he is probably, oh, one of the top professionals in international aquatic biology. So I don't want to assume anything, but I mention this for the purpose of the questions here.

.ou heard the information on the aquatic life of Biscayne Bay and Card Sound, and to me, as an amateur in this field, th's looks pretty good to me. Now, with ideal conditions, such as has been described, even if temperature were an involvement, would you recommend taking 2.7 billion gallons of water out of Biscayne Bay and changing those currents and putting it back? What would you think would happen to the biota there if you did that, just taking the velocity of this operation?

DR. TARZWELL: Well, in the first place, I think that it would disrupt the currents. They have been flowing northward, and there is a sill around Card Sound like a bowl or saucer. I don't know which way it would go for sure. I believe it would disrupt the currents.

MR. STEIN: Would you take the chance?

DR. TARZWELL: I would rather not, if I were doing it myself. In addition, the thing that is also serious is this killing of the organism that you put through. You see, you're going to be putting through a very significant portion of the water in this area here, and you're killing at least a large portion of the organisms.

MR. STEIN: I am going to get to that in a minute. The point is, would you put 2.7 billion gallons of water in Card Sound with the conditions that they have there? Do you think that you might change the currents if you put that volume in?

DR. TARZWELL: If I were to make the decision, I would decide not to because I know that such a change of water would disrupt environmental conditions, and I don't know what would be the effect of drawing in such large quantities of oceanic waters.

MR. STEIN: Here is the point that I am trying to get at, Dr. Tarzwell. If we are dealing with pretty bad conditions, you disrupt the conditions, you may take a chance; but with conditions that have been described in the report that I have heard this morning in Card Sound and in Biscayne Bay, and those biological conditions, would you want to take a chance in changing that?

Dr. Clarence M. Tarzwell

DR. TARZWELL: In view of the fact that we have here a national monument, and a State underwater park, and an outstanding recreational area, that if protected will yield good to the general public from now on, I would not.

MR. STEIN: Let me ask you one more thing. You say if we take the water through the plant -- I don't know what you call it -- sterilizing or pasteurizing it, by heating it, you would be killing a lot of organisms?

DR. TARZWELL: Yes.

MR. STEIN: Now, supposing we had that canal at Card Sound 6 miles away where you have a drop of a half degree or a degree of temperature, any organisms that we didn't kill in the plant we knock off in the canal, wouldn't we?

DR. TARZWELL: High temperature in the condenser would kill organisms. Longer exposure to high temperature in the ditch would result in the kill of many of those organisms which did not go through the condensers or were not killed by the short exposure in the condensers.

MR. STEIN: Any that we missed in the plant we would catch in the canal?

DR. TARZWELL: Pretty much so.

MR. STEIN: All right. Any other questions? Thank you very much, Dr. Tarzwell.

MR. THOMAN: I would like to next call on Mr. John C. Raftery, the Superintendent of Everglades National Park, and Biscayne National Monument.

Mr. Raftery.

JOHN C. RAFTERY, SUPERINTENDENT,
EVERGLADES-BISCAYNE NATIONAL PARK SERVICE,
EVERGLADES NATIONAL PARK,
HOMESTEAD, FLORIDA

MR. RAFTERY: Mr. Chairman, conferees, ladies and gentlemen, I am John C. Raftery, Superintendent of Everglades National Park, and Project Supervisor of the proposed Biscayne National Monument.

It is the purpose of the National Park Service to protect, preserve and provide for the use of the Nation's outstanding scenic, scientific, historic and recreational lands and waters.

Biscayne National Monument, in Dade County, is an exceptionally unique area, in that all of these values are present within it. Biscayne National Monument has been set aside as a part of every American's heritage. As such, it must be managed under a policy that will assure that its land and waters and associated plant and animal life will remain unimpaired for the use and enjoyment of this and future generations.

The policies of the National Park Service reflect a principle of government, established within our lifetime, that some yields from our land and waters can be measured in terms of social benefit and individual happiness, as well as in dollars. This principle in effect is an expression of the concept that preservation of places of natural beauty is of proper governmental concern, and that representative areas of the Nation's priceless natural treasures should be set aside for the public's use and enjoyment.

It follows from this that neither individuals nor special interests have the right to ignore the public welfare or deny or thwart the use and enjoyment of nationally significant resources and assets. This point applies to the Turkey Point situation where a corporate entity is attempting to maximize profits at the expense of the public's environment in the South Biscayne Bay-Card Sound area.

John C. Raftery

As the National Park Service administrator of Biscayne National Mounment, I respectfully wish to have entered into the record of this conference some questions and reservations regarding the Florida Power & Light Company's plan to dump thermally polluted waters into Card Sound. They are as follows:

1. What effect will the daily removal of 1/16th of the total water volume of South Biscayne Bay have upon the marine ecology of the area?

What effect will this withdrawal have on the bay bottom (due to current scour) near the inlet and outlet areas of the canal?

What changes will take place in the tidal regimen of the area due to such tremendous withdrawals? It is estimated, for instance, that the amount of water pumped into Card Sound will exceed the amount that daily moves in and out of this area with the tides.

2. During the warmer months it is certain that large volumes of heat killed planktonic organisms will be pumped into Card Sound. It seems likely that this will result in turbidity, eutrophication, reduced oxygen levels, and changes in or elimination of certain plant and animal communities. How far these effects

will be felt is unknown, but I feel that they will be registered in the waters of Biscayne National Monument.

3. The tremendous volumes of coolant water withdrawn from south Biscayne Bay will no doubt alter the circulation of waters in this area. Will this altered circulation result in an influx of polluted waters from urban areas lying to the north? Will thermally polluted waters from Card Sound recirculate into the south Biscayne Bay waters of the monument?

4. The proposed cooling canal will intersect at least 10 streams which drain coastward from the mangroves and interior marshes between Turtle and Mangrove Points (see U. S. Coast and Geodetic Arsenicker Key, Florida quadrangle map, 1956).

What role do these streams now play in the ecology of the surrounding land areas and offshore waters and how significant will the effect of their loss be?

5. What effect will the cooling canal have upon the salt water line in the areas adjacent to it? Will it not at certain times cause the salt front to move inland by providing a large area for penetration of saline waters into the Biscayne Aquifer?

At other times will not this wide and very deep cooling canal result in considerable loss of freshwater from the Biscayne Aquifer?

6. During the warmer months the temperature of Card Sound waters would be significantly greater than those of surrounding water bodies due to the discharge of heated waters from the cooling canal system. In effect, it appears that a thermal barrier to migrating animal life would then be present. How will the migrations of fish, shrimp, lobsters, stone crabs, etc., be affected by such a barrier?

7. Will larval and juvenile forms of aquatic animals be affected? If so, how many species will be involved and in what quantities (percent of population) can mortality be expected to occur? These are very important but unanswered questions.

8. Will thermal pollution damage extend to the turtle grass beds on Cutter and Card banks?

9. In at least two States the AEC is being confronted with demands for tighter restrictions on releases of radioactive wastes. Yet this potential hazard has not been seriously considered by the Dade County Pollution Control Board. I believe that this

could become a very serious matter since living organisms do in time concentrate radioactive materials to levels which can threaten public health as well as natural values. I strongly urge that the radioactive waste aspects of the cooling system under discussion be seriously considered.

The serious uncertainties enshrouding the Florida Power & Light proposal for a cooling canal seem ample justification for denying approval of this plan. Indeed such action is imperative in order to assure that Biscayne National Monument is preserved for the enjoyment and benefit of this and future generations.

MR. STEIN: The attachment should be included in the record as if read.

(The above-mentioned attachment follows.)

Parkscape U.S.A.

South of Miami, the upper Florida Keys form a narrow chain of barrier islands separating the Atlantic Ocean from south Biscayne Bay while the shallow offshore waters harbor the northernmost range of living coral reef along the Atlantic Coast. Sheltering mangrove trees line the bay shores of the Keys, which, together with the submerged lands of the bay and the adjacent ocean, have been proposed as Biscayne National Monument.

Proposed

BISCAYNE National Monument

Florida

In their present relatively undeveloped natural state, the upper Florida Keys and the adjoining waters and submerged lands of Biscayne Bay and the Atlantic Ocean contain a rare combination of land and water resources found nowhere else in the continental United States.

Shallow Biscayne Bay and the offshore reefs of the Atlantic Ocean provide an underwater wonderland of colorful corals and sponges, seaweeds and grasses, starfish and shellfish, crabs, turtles and other tropical marine life. The entire area is an enormous underwater nursery where reef and pelagic fish hatch and grow before venturing out into the ocean.

The high ground of the Keys is largely covered with 20 to 40 year-old second growth trees such as palms, mahoganies and mangroves, said to be the best that remains of south Florida's once splendid tropical forest. If preserved, this second growth forest will eventually approximate the size and composition of the original forest.

A preliminary professional report entitled *Florida Coral Reefs-Islandia,* prepared by the National Park Service and the Bureau of Outdoor Recreation, was distributed to the public for comments and suggestions in July 1965. Following a review of comments received, a final report entitled *Biscayne National Monument* was issued in September 1966.

The present proposal recommends the preservation of a portion of the upper Florida Keys, together with portions of the adjoining waters and submerged lands of Biscayne Bay and the Atlantic Ocean.

The national monument would preserve for public use and enjoyment a total of 105,000 acres, 4,000 acres of which would be land and 101,000 acres of water and submerged land. State-administered John Pennekamp Coral Reef State Park, immediately south of the proposed area, would complement but would not become a part of the Biscayne National Monument. A 90-acre county area known as Elliott Key Park is proposed for inclusion in the national monument.

The national monument boundaries on the north would run between Boca Chita and Sands Key, on the east would follow the 60 feet depth line in the Atlantic Ocean, on the south would run along the northern boundary of John Pennekamp Coral Reef State Park and through Broad Creek, and on the west would generally parallel the mainland and follow the outer dredging limit line.

The Secretary of the Interior's Advisory Board on National Parks, Historic Sites, Buildings and Monuments endorsed the proposal first in 1964 and again in April 1966.

Development of the Biscayne National Monument would include visitor contact areas on the mainland near Homestead Bayfront Park and on Key Largo along Card Sound. Here visitors would find exhibits to interpret and invite land and underwater exploration. Conducted tours would be available from these points to all parts of the monument.

On the Keys development would provide change shelters for swimmers, primitive campgrounds for overnight use, and land and underwater interpretation. Other visitor activities would include fishing, diving, snorkeling, bicycling, picnicking, and hiking. In the colorful, offshore reef unusual underwater attractions might include self-guiding nature trails, viewing rooms, conducted snorkeling trips, trips in glassbottom boats, and perhaps underwater television programs. Large stretches of water only one to two feet deep offer unusual opportunities for children to fish-watch and observe the interesting underwater life. Since no vehicular access is planned to reach the upper Keys, public boats and private craft will provide the only means of transportation for those who plan to use the varied resources of the area.

Establishment of the Biscayne National Monument would require an authorizing Act of Congress and an appropriation of funds to purchase the privately owned lands within its boundaries.

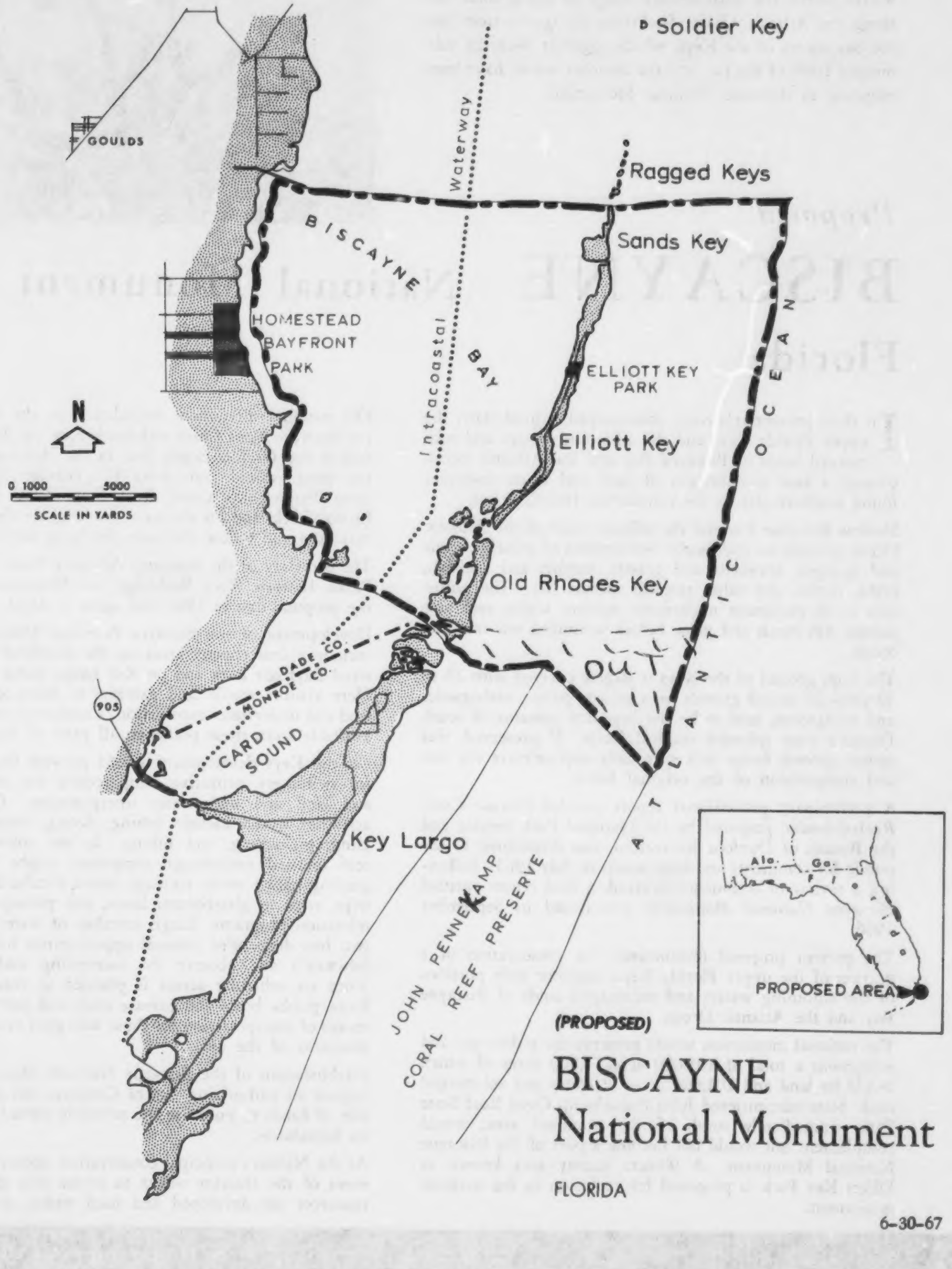
As the Nation's principal conservation agency, the Department of the Interior works to assure that non-renewable resources are developed and used wisely, that park and

U.S. Department of the Interior
National Park Service

310-a

recreational resources are conserved, and that renewable resources make their full contribution to the progress, prosperity and security of the United States—now and in the future.

The National Park System, of which Biscayne National Monument would be a unit, is dedicated to conserving the natural, historical and recreational heritage of the United States for the benefit and enjoyment of the people.


Soldier Key
GOULDS
Waterway
Ragged Keys
Sands Key
BISCAYNE BAY
HOMESTEAD BAYFRONT PARK
Intracoastal
ELLIOTT KEY PARK
Elliott Key
ATLANTIC OCEAN
N
0 1000 5000
SCALE IN YARDS
Old Rhodes Key
DADE CO.
MONROE CO.
905
CARD SOUND
OUT
Key Largo
JOHN PENNEKAMP CORAL REEF PRESERVE
Ala.
Ga.
Fla.
PROPOSED AREA

(PROPOSED)

BISCAYNE
National Monument

FLORIDA

6-30-67

MR. STEIN: Any comments or questions?

You know, this conference has not been called to deal with radioactive material. Unless someone has some serious question, maybe we should consider it off-limits. But you did raise a very interesting point.

You say, "In dealing with radioactive materials I believe that this could become a very serious matter, since living organisms do in time concentrate radioactive materials to levels which can threaten public health as well as natural values."

If the plant is going to heat things up and kill off all living organisms, they won't concentrate. Maybe they are doing us a service.

MR. RAFTERY: On the other hand, these radioactive materials could be circulated out into the Atlantic where they could be consumed by animals.

MR. THOMAN: John, we have had preliminary discussions with the Florida Department of Air & Water Pollution Control and we shall pursue within the next several months much more serious discussions concerning the emissions of radioactive material from plants of this general type, and I can assure you on the part of the Southeast Region of the FWPCA that we will be discussing this in great detail with the States, and looking into water quality standards concerning the discharge of radioactive materials. So that will be done. As Mr. Stein said, it probably is off limits for this particular meeting.

Thank you.

MR. STEIN: John, let me get back on limits here. In 4 and 5 you talk about the proposed cooling canal, what effect the cooling canal will have. I assume you mean the canal at Card Sound in all of these stages.

MR. RAFTERY: Yes, sir.

MR. STEIN: Maybe I can be corrected, but as far as I have been able to ascertain -- no one contends, and I don't think the company does -- that this is the cooling canal. The notion is that if this is not going to reduce the temperature more than a degree or possibly a half degree, no one is contending cooling qualities for this canal. Is that correct?

MR. RAFTERY: I stand corrected.

MR. STEIN: Thank you.

Are there any other comments? If not, thank you very much.

MR. RAFTERY: Thank you for this opportunity, Mr. Stein, to comment on the impact that the discharge of heated waters will have on the viability and integrity of Biscayne National Monument.

MR. STEIN: Thank you.

MR. THOMAN: I'd like to next call on Dr. Carl J. Sindermann, Director of the Tropical Atlantic Biological Laboratory of the United States Bureau of Commercial Fisheries.

RICHARD T. WHITELEATHER, REGIONAL DIRECTOR,
U. S. BUREAU OF COMMERCIAL FISHERIES,
REGION 2, ST. PETERSBURG, FLORIDA
(Read by Dr. Sindermann)

DR. SINDERMANN: Mr. Chairman, ladies and gentlemen, I am Carl Sindermann, Director of the Tropical Atlantic Biological Laboratory. I have a statement that was provided me by Richard T. Whiteleather, Regional Director, U. S. Bureau of Fisheries, Region 2, Gulf and South Atlantic.

The statement is as follows:

Our official expression of concern regarding Florida Power & Light Company's proposal to discharge heated condenser cooling water into Biscayne Bay was given in the Fish and Wildlife Service letter to the U. S. Atomic Energy Commission dated January 25, 1967.

The pertinent paragraphs in this letter are as follows:

One problem that we foresee -- this is January, 1967. One problem we foresee is the possible effects of increased water temperature on aquatic organisms. Large volumes of heated water discharged into an aquatic environment may not be sufficient always to cause mortality among the organisms present but subtle biological changes could occur causing long-term changes in the environment.

Going on with Mr. Whiteleather's statement:

We are also concerned with the company's proposal to discharge heated effluent into Card Sound and its expected effects on the marine resources involved. Our views in this respect have been transmitted earlier through Regional Coordinator C. Edward Carlson, BSF&W, Atlanta. We are, of course, particularly concerned with the protection of commercial fisheries dependent on these resources.

The essence of that statement is as follows:

Discharge of heated condenser cooling water into the semi-tropical waters of Biscayne Bay from the operation of two fossil-fueled generating units, which require 635 cubic feet per second each, has already caused extensive damage to marine resources in the area adjacent to the Biscayne National Monument at Turtle Point. The discharge of an additional 2,980 cubic feet per second of condenser cooling water would cause widespread damage to the marine sources. Such a practice is not consistent with the policy and objective of the Water Quality Act of 1965.

Turning finally to Mr. Whiteleather's statement:

> Although the commercial fishery production of Card Sound is admittedly low, chiefly bait shrimp, crabs, and spiny lobster, it provides protected habitat for larval and juvenile finfish and shellfish that contribute to commercial fisheries operating beyond its confines. One such fishery is that of Biscayne Bay. In 1968 landings for this area totalled nearly 1.5 million pounds and were worth about $865,000 (ex-vessel value). These totals do not include the lucrative Biscayne Bay bait shrimp fishery that realized more than $600,000 from its operation for the same period.

Col. A. S. Fullerton

We appreciate the opportunity to place in the record the above material on the project area's commercial fisheries, and the appended letters that I read from.

MR. STEIN: Thank you, Mr. Sindermann.

MR. THOMAN: We next would like to call on Colonel A. S. Fullerton, the newly appointed District Engineer from the Jacksonville District of the United States Army Corps of Engineers. Colonel Fullerton.

Your predecessor was a good friend of ours, and we certainly appreciated having him assigned to us, and we are glad to welcome you to Jacksonville.

COLONEL A. S. FULLERTON, DISTRICT ENGINEER,
JACKSONVILLE DISTRICT, U. S. ARMY CORPS OF ENGINEERS,
JACKSONVILLE, FLORIDA

COL. FULLERTON: Thank you.

Do you need further identification, Mr. Reporter?

MR. STEIN: By the way, do you have a copy of your report?

COL. FULLERTON: I don't have an extra one.

MR. STEIN: All right, go ahead.

Col. A. S. Fullerton

COL. FULLERTON: Mr. Chairman, conferees, and ladies and gentlemen: The Corps of Engineers welcomes the increased emphasis being placed on pollution. We are vitally interested in the subject as an agency charged with certain statutory responsibilities and as an agency involved ourselves in waterfront construction.

Our statutory responsibilities have to do with the issuance of Department of the Army permits for any type of waterfront construction. Section 10 of the River & Harbor Act of 3 March 1899 requires that permits be issued for any type of work to be placed in the navigable waters of the United States and Section 13 of the same Act makes it unlawful to deposit any type of refuse into the navigable waters. The somewhat limited authorities contained in this old statute have been materially enlarged in recent years by passage of the Fish & Wildlife Coordination Act of 1958 and the Water Pollution Control Act P. L. 84-660, as amended, with further implementation thereof through Executive Order No. 11288 (now superseded by E. O. No. 11507 dated 4 February 1970).

In the processing of a permit application for work to be performed in the navigable waters, the

Corps of Engineers seeks the comments of interested State and local authorities as well as those of the general public. If State or local laws require a license or approval from a properly constituted agency, it is the policy of the Corps of Engineers to decline to issue a permit even if the work is otherwise unobjectionable unless such local and State approval has been secured.

Applications are carefully coordinated with the several agencies of the Department of the Interior in accordance with a "Memorandum of Understanding" entered into between the Secretary of the Interior and the Secretary of the Army in July of 1967. Through this procedure we are assured that very careful attention is given to any position taken by the Department of the Interior agencies before final action is taken.

Pollution is, of course, of basic concern to the Federal Water Pollution Control Administration and we look to that agency generally for the expertise in that field. However, we have recently initiated a procedure by which if there is to be any discharge of effluent from a proposed installation, we require that the identity of the pollutant be fully set forth in order that the public in general may be advised of this subject at the time the application is under consideration.

Col. A. S. Fullerton

The final decision of the Department of the Army cannot be made until after evaluation of all relevant factors, including the effect of the proposed work on navigation, fish and wildlife, conservation, pollution, esthetics, ecology, and the general public interest. You may be interested to know that our right to deny a permit for reasons other than navigation has been challenged in the Federal courts. This case has not been finally settled but we are proceeding with the assurance that we do have such authority.

Where adverse effects are indicated, an applicant is given the opportunity to reduce such effects or to revise his plans in such manner that the effects may be minimized or eliminated entirely.

In the field of dredging there is an acute problem with respect to temporary pollution during the progress of the work. In all dredging permits we now include a very restrictive clause which requires the permittee to abide by any present or future regulations of either the State pollution control agency or the FWPCA. Where violations of these regulations or water quality standards occur, we depend on the State agency or the FWPCA to determine the extent of the violation, but the Corps of Engineers has the responsibility in the final analysis for the enforcement of the permit provisions.

Here in the Biscayne Bay area, application of the Florida Power & Light Company to discharge cooling water from their proposed Turkey Point nuclear powerplant has been held in abeyance since 1967 because of the concern expressed by the FWPCA concerning the possible adverse effect of thermal pollution. It is our understanding at this time that certain modifications to the discharge system will be proposed by the applicant with the hope that the thermal effects will be reduced to an acceptable level. They have not as yet submitted a revised application to us for the necessary permit, but when they do, all agencies will be given a full opportunity to review the plans and comment thereon.

Our enforcement actions under the Refuse Act (Section 13 of the 1899 Act) which I mentioned earlier are related to industrial discharges, oil pollution, and any other refuse. Our efforts along these lines are being intensified in consonance with the National Environmental Policy Act which was approved by the President on 1 January 1970. The Supreme Court has ruled that oil, including gasoline, may be considered as "refuse" under the meaning of the Act and we have taken numerous cases to court in the Jacksonville District. Many of these have resulted in convictions and we have several pending at this time. I would like at this point to acknowledge the excellent cooperation that we receive from the Coast Guard in detecting and reporting incidents of oil pollution.

Going now to our own Corps of Engineers operations, we work closely with all appropriate agencies in an effort to reduce or eliminate pollution. In dredging operations, this presents a problem of considerable proportions. Our entire system of spoil disposal is under constant review. A few months ago we participated in a conference held in our Division office in Atlanta with FWPCA officials and have since carried on correspondence with that agency in an effort to establish spoil area control standards which will achieve our mutual aims.

In administering both permit work and our own work in the field, the Corps depends on State and Federal pollution control agencies for assistance in the following areas:

Col. A. S. Fullerton

1) Gathering of water quality data and providing technical advice on possible effects, both adverse and beneficial, on water quality by works constructed under Department of the Army permits.

2) Procurement of proof of violations of regulations and/or water quality standards by a permittee and presentation to the Corps if corrective measures are indicated.

3) Provision of advice and technical assistance as to how a permittee's project or a Corps of Engineers project might be modified in construction and/or operation to maintain or enhance water quality.

The corps of Engineers appreciates the opportunity to be present at this meeting today and you may be assured of our full and active cooperation in the field of pollution control.

That concludes my statement.

MR. THOMAN: Thank you very much, Col. Fullerton. Mr. Stein indicated that he had one or two questions to ask you. The Assistant Secretary called him out.

I do have a couple of questions that I would like to elicit some information on. Am I correct in assuming that you have stated that the Corps of Engineers -- that Florida Power & Light has not applied for a permit for the dredging of this canal from the Corps of Engineers which they are now proceeding on?

COL. FULLERTON: Is this the one at Card Sound?

MR. THOMAN: Yes.

COL. FULLERTON: No, they have not.

MR. THOMAN: Before they hit one of these 10 streams, freshwater streams that Mr. Raftery indicated that they will bisect with this canal, do they have to have a permit?

COL. FULLERTON: I would say not unless they were considered a navigable waterway.

MR. THOMAN: In other words, they would just need the permit. If you assume that they are not navigable they would then need the permit only when they cut into Card Sound?

COL. FULLERTON: That's correct.

MR. THOMAN: What would stop them from just going up to the so-called bulkhead line on Card Sound and stopping the canal as they did with Grand Canal? That has never been cut through.

COL. FULLERTON: That's correct.

MR. THOMAN: Yes, that is correct, but they still dug the canal.

COL. FULLERTON: Well, on Grand Canal I can't say. On Card Sound, 1) we do not in general assert jurisdiction on upland canals. In other words, if an owner is digging a canal on his own property in the dry, so to speak, it hardly could be considered to be a Federal navigation project, you see, or have a relationship to Federal navigation laws; and so I would say that in one sense one could say that there was nothing to permit them from coming pretty close to Card Sound.

When it cuts through to Card Sound, then they are altering a navigable waterway, you see. You get into a very difficult proposition.

MR. THOMAN: I recognize this. That is why the 1967 permit application has never been granted in Grand Canal, but they are up to the bulkhead line, and the water still goes out there.

COL. FULLERTON: I haven't --

MR. THOMAN: Yes, it does, and it still has never been cut through.

COL. FULLERTON: You are asking a question and making a statement.

MR. THOMAN: I made a statement, Colonel. I have nothing else.

MR. STEIN: Let me ask you this. You indicated in your statement that if it is against the State policy you generally don't issue a permit.

COL. FULLERTON: That is correct.

MR. STEIN: In other words, let us suppose for the sake of argument that the State would not approve it, and they would ask the Federal Water Pollution Control Administration and the Department of the Interior for its comment. What do you think the chances of issuing a permit would be to cut through to a navigable waterway if both the State and the Department of Interior said that would be deleterious?

COL. FULLERTON: As I said, generally speaking, if the State objects to a permit, it is the policy of the Corps of Engineers not to grant the permit. Also, I think you know that we coordinate with the Department of the Interior.

MR. STEIN: Let me say this. As you know, we go before the same committee, and I regard the Corps of Engineers as a sister agency for water resource development, and I have had no differences with the Corps of Engineers over the years. But suppose we get the hypothetical question of someone digging a six mile canal in an upland area without having the permission or the green light of the State agency or the Department of Interior to go ahead. We recognize that the Corps of Engineers is going to have to make the judgment and approve it, and both the Department of Interior and the State are going to have to make a recommendation to the Corps. Now, the question that we have to face is something that Mr. Thoman raised. If the canal is dug for six miles or right up to the bulkhead line, are we going to let them complete it, or just let it leak in even though they don't have a permit?

COL. FULLERTON: Here I think once more we are venturing. As you mentioned in your opening statement, Mr. Chairman, I believe that you did mention the fact that the Interior Department was going to address this matter to the Justice Department. If the Florida Power & Light Company didn't cease to dig, this may be what you have to do. In other words, you are in a question of law where our authority really only extends to approval.

MR. STEIN: Let me put it this way -- and, again, I have worked with the Corps of Engineers lawyers for years -- the point is, the canal may end up in an upland area where someone has dug a ditch that's dry. Anyone can dig a ditch.

COL. FULLERTON: As far as the Department of Interior, we don't have much jurisdiction over that. But once they begin putting water in that and running water through it, then I think we both have a little different application and jurisdiction. This is possibly true, sir. I can't comment definitively. I would ask for an opinion for the record. That is the best I could do.

MR. STEIN: I understand that. But before that ditch or canal can be broken through to Card Sound and Biscayne Bay, or navigable water, and say about 2 million gallons of water a day are going to be poured into a navigable waterway, would you think that under the Corps' authority they need a permit from the Corps before they could do that?

COL. FULLERTON: Yes.

MR. STEIN: I think that I would agree with you. Thank you. Are there any other comments or questions? If not, thank you very much.

MR. THOMAN: I have no other indications

from any representatives, other Federal agencies that wish to make a presentation. If there are any, would you please come forward?

Since there are none, the immediate Federal part of the presentation is concluded, Mr. Stein.

MR. STEIN: Now, we anticipate running until 5 o'clock. Before going on to Florida's presentation, we will recess for 10 minutes.

(Whereupon a short recess was taken.)

MR. STEIN: Let's reconvene.

Mr. Reed.

MR. REED: I have an announcement for Mr. Kaufman, who may be in the room. Mr. Kaufman, it will not be possible to get you on this afternoon, because the rest of the afternoon will be taken up by the State and the company's presentation. We are trying to get as many people to testify tomorrow from the general public as we can, but I do not think we can make an exception, and if you are unable to be here tomorrow, we can take your written statement.

I will turn this part over to Mr. Vincent Patton, Executive Director of the Florida Department of Air and Water Pollution Control.

VINCENT D. PATTON, EXECUTIVE DIRECTOR,
FLORIDA DEPARTMENT OF AIR AND WATER POLLUTION CONTROL,
TALLAHASSEE, FLORIDA

MR. PATTON: Thank you, Mr. Reed.

Mr. Stein, conferees, and ladies and gentlemen, our presentation is rather short, and in memorandum form, which will be made available to the Reporter for the record.

If I may go through it, there is a Memorandum under date of February 20, 1970. "Subject: Florida Power & Light -- Turkey Point, Dade County -- Thermal Pollution.

"The Board was presented a snyopsis of the problem in September of 1969 via formal report." This is made a part of this memorandum as an enclosure.

"There have been many reports prepared by various educational institutions, consultants and agencies, and numerous meetings and hearings regarding this problem. Several of those meetings, hearings and reports will be referenced here.

"A statment of facts follows:

Vincent D. Patton

"1. Florida Power & Light presently is operating two fossil fuel power units capable of 432,000 KW of electricity and discharge about 635 cubic feet per second (285,000 GPM) of heated water at Turkey Point, Dade County, Florida. These plants discharge water at about 8°F above normal temperature during the summer months (August). (1)

"2. Operation of the units noted in (1) above caused a temperature increase 'so as to cause -- damage -- to the aquatic life or vegetation of the receiving waters.' This occurred late June, 1969, and is documented by a report (1), received by the Department February 18, 1970.

"3. The present operation noted in (1) above has been conducted under a two year exception to the regulations given by the Florida Air & Water Pollution Control Commission (Board) November 7, 1967. This expired November 6, 1969.

"4. The Dade County Pollution Control Board granted a temperature variance for the present operation February 20, 1969. The variance has been continued and on February 18, 1969, the Board extended the variance until July 1, 1971. (1)

"5. Florida Power & Light is building two nuclear power units 760,000 KW which will each discharge approximately 1,490 cubic feet per second (670,000 GPM) which, without cooling, will be subject to a temperature rise approximately 15°F above normal bay temperatures.

"6. Various schemes have been presented to provide some cooling for all plants (2), however, a formal engineering presentation for approval by the State has not been submitted to date.

"7. The most recent proposal is to convey the heated water to Card Sound to avoid recirculation to the intake points, and to provide 150 percent dilution water to provide a maximum discharge temperature of 5°.

a. The 5° maximum proposed is probably in terms of means and will probably rise above that level part of the time of operation.

b. The State has not received any such proposal except by verbal transmission.

"Summary:

"1. The Florida Power & Light operation has damaged the waters of the State by thermal influence, although at the time of occurrence it was operating under no exception.

Vincent D. Patton

"2. The company has not made a formal engineering presentation to the State defining the method of cooling and/or disposal which provides supporting evidence that the discharge will not violate the state temperature regulation 28-5.05(2) (9).

"3. Evidence or conclusions presented in several reports (1), (3), and (4) indicate that a 5 °F rise, during the summer months, will damage or harm aquatic life. The probability of damage is increased if the 5°F rise is proposed as an average.

"Conclusion:

"1. Florida Power & Light Corporation should submit a formal engineering proposal to the State, pursuant to Chapter 403.061. The proposal must include sufficent evidence to indicate that the thermal discharge will comply with state regulations.

"2. In order to resolve the complex technological problem associated with cooling thermal discharges and the resulting ecological effect and to establish firm commitments pursuant to protection of the state waters, the Governor of Florida requested a Federal Conference be held."

Vincent D. Patton

REFERENCES

(1) Report on Thermal Pollution of Intrastate Waters of Biscayne Bay, Florida, February 1970, Federal Water Pollution Control Administration.

(2) Report to Florida Air & Water Pollution Control Board, September 1969.

(3) "Temperature and Aquatic Life"
"Laboratory Investigation Series"
Federal Water Pollution Control Administration, December 1967.

(4) Report of the Committee on Inshore and Estuarine Pollution - "The Hoover Foundation," March 1969.

(5) Meeting Minutes of Florida Air and Water Pollution Control Commission, November 7, 1967.

Florida Air and Water Pollution Control Commission

MINUTES

November 7, 1967

The Florida Air and Water Pollution Control Commission met in the Cabinet Room of the Governor's Office at 9:00 a.m. Tuesday, November 7, 1967.

Members present were:

Hon. Claude R. Kirk, Jr.	- Governor and Chairman
Hon. Tom Adams	- Secretary of State
Hon. Earl Faircloth	- Attorney General
Hon. Doyle Conner	- Commissioner of Agriculture
Hon. Nathaniel P. Reed	- Commissioner
Hon. John P. Roberts	- Commissioner

Mr. Reed presented an agenda to the commission.

The minutes of the September 5, 1967, meeting of the commission were approved as distributed.

Consideration was given to a proposal to validate existing rules and regulations of the Florida State Board of Health pertaining to air and water pollution control, Chapters 170C-5, 170C-7, 170C-9, and 170C-10, Florida Administrative Code. It was noted that the act which created the commission automatically validated the air and water pollution control rules and regulations existing at the time of the effective date of the act. However, in order to clarify exactly which

335

rules and regulations were to be enforced by the commission, it was felt that the commission should take formal action on specific chapters of the Florida Administrative Code relating to air and water pollution. Motion was made by Mr. Reed and seconded by Mr. Faircloth that these rules and regulations be validated. The motion passed unanimously.

A report was given by Mr. David B. Lee, Director of the Bureau of Sanitary Engineering, on the status of the water quality standards and the plan of implementation submitted to the Federal Water Pollution Control Administration, as required by Public Law 89-234. Mr. Lee reported that the water quality standards submitted by the State of Florida have been approved by the Administration, with the exception of further study on ocean outfalls. A copy of the document as submitted to the Federal Water Pollution Control Administration was given to each commissioner.

Mr. Vincent Patton of the Bureau of Sanitary Engineering, reported on industrial waste problems, including the phosphate, pulp and paper, citrus, and cane sugar industries. Specific causes and sources of such pollution were contained in a written report submitted to each commissioner.

Mr. Ralph Baker of the Bureau of Sanitary Engineering, reported on problem areas in domestic waste disposal. The sources of existing pollution from domestic wastes were contained in a report submitted to each commissioner.

Upon the recommendation of the Bureau of Sanitary Engineering, it was moved by Mr. Reed and seconded by Mr. Faircloth that permission be granted to cite by notice and order to correct, or otherwise notify by appropriate means, the persons listed in Appendix II of Mr. Patton's report and the municipalities and other persons listed in Appendices I and II of Mr. Baker's report, so that compliance with the rules and regulations of the commission will be achieved. The motion passed unanimously.

In reply to an inquiry by Mr. Adams, Mr. Lee said that the development of a permit system as authorized by Chapter 67-436, Laws of Florida, is being held in abeyance until such time that a director is employed by the commission.

Mr. Bjarne Anderson, attorney with the State Board of Health, discussed pending litigation in air and water pollution, giving the status of 16 cases.

Dr. Wilson T. Sowder, State Health Officer Florida State Board of Health, appeared before the commission to urge the commission to provide more attorneys to handle the legal work involved in the enforcement of the new pollution control act. No action was taken on the request.

Mr. Sidney Berkowitz, Bureau of Sanitary Engineering, reported on the continuing effort of the bureau to upgrade the salary schedule for engineers and technicians who work in air and water pollution control. He requested that the commission approve the appearance of the bureau's staff before the Budget Commission to request the implementation of a salary schedule which is commensurate with existing salaries for comparable work around the Nation so that the bureau can retain its present staff and to enable it to compete for additional technical people. Information substantiating Mr. Berkowitz's request was submitted to each commissioner. Mr. Faircloth moved that Mr. Berkowitz be authorized to present this request to the Budget Commission as outlined in his report. The motion was seconded by Mr. Reed and passed unanimously.

Mr. Lee presented a request from the Florida Power and Light Company that an exception to the water temperature limitation imposed by the commission's standards be granted for the cooling waters discharged into Biscayne Bay from the company's Turkey Point electrical generation plant. Mr. Lee recommended that this exception be granted, provided, however, that Florida Power and Light Company initiate studies to establish the "background" data on the water quality and the existing condition of the marine biology and ecology of the area.

Mr. Adams questioned the advisability of adopting standards of water quality, then proceeding to grant exemptions to them; and asked if the company would suffer any undue hardship if the request were held in abeyance until the commission could give the matter more study. Mr. Davis, representing the company, explained that the temperature limitation adopted by the commission was often exceeded in this particular area of Biscayne Bay as a result of natural geographic and meteorological conditions. Mr. Reed said that this was one of the few areas in Florida where this condition exists naturally, and that the Federal Water Pollution Control Administration acknowledged this fact when approval was given to the Florida plan.

Mr. Davis said that if there is any scientific proof that there is any degradation of these waters by increased temperatures after reasonable mixing, the Florida Power and Light Company would take corrective action to the satisfaction of the commission.

It was moved by Mr. Adams, seconded by Mr. Reed, and passed unanimously, that the exception be granted on a temporary basis until the study being conducted by the biologists from the University of Miami is completed, and the matter reevaluated at that time.

Mr. Adams commended the Bureau of Sanitary Engineering for the information presented, but suggested that material for future meetings be furnished by 5 o'clock on the third workday preceding the meeting, as is the practice with many other State agencies.

Mr. Reed reported that interviews are still being conducted in seeking a director for the commission and should be completed within two to three weeks, at which time the next meeting will be called.

There being no further business to come before the commission, the meeting was adjourned at 9:50 a.m.

Governor and Chairman

FLORIDA AIR AND WATER POLLUTION CONTROL COMMISSION

RESOLUTION NO. 67-2

WHEREAS, Chapter 67-436 created the Florida Air and Water Pollution Control Commission; and

WHEREAS, the act provides that all local pollution control programs must be approved by the Commission as adequate to meet the requirements of the act and any rules and regulations adopted pursuant thereto; and

WHEREAS, it appears that the said Commission cannot adequately review and approve such local programs by the effective date of Chapter 67-436; NOW, THEREFORE,

BE IT RESOLVED by the Florida Air and Water Pollution Control Commission that temporary approval is hereby given to all existing local air and water pollution control programs until such time as each program can be reviewed and specific approval granted by the said Commission.

BE IT FURTHER RESOLVED that the responsible administrative or governing body of each local program is hereby granted temporary authority to continue to issue, deny or revoke permits for the operation, construction, expansion, or modification of any installation for air or water pollution control where such action is consistent with any local law or ordinance and with Chapter 67-436 and the Resolutions of this Commission until such time as each program can be reviewed and specific authority granted by the Commission. No such permit issued hereunder shall vest in the permittee any rights in excess of those such permittee would have possessed prior to the effective date of Chapter 67-436, unless such rights are consistent with the provisions of Chapter 67-436.

DONE and ORDERED this 5th day of September, 1967.

FLORIDA AIR AND WATER POLLUTION
CONTROL COMMISSION

Claude Kirk
Governor and Chairman

Tom Adams
Secretary of State

Earl Faircloth
Attorney General

Doyle Conner
Commissioner of Agriculture

Commissioner

John V. Roberts
Commissioner

REPORT TO

FLORIDA AIR AND WATER POLLUTION CONTROL BOARD

Thermal Pollution

Florida Power and Light

Dade County, Florida

Prepared by

Department of Florida Air and Water Pollution Control

September, 1969

THERMAL POLLUTION

Thermal pollution has been defined as man-caused deleterious changes in the normal temperature of water. It is well documented that increased temperatures disturb the ecological balance of the aquatic and marine environment and that many kinds of aquatic plants and animals can be harmed or killed as a result of a relatively small rise of the temperature around them.

Fishes are classed as poikilothermus or animals whose body temperature follows changes in environmental temperatures rapidly and precisely and body temperatures differ from that of surrounding water by only 0.9 - 1.8°F. (1). Therefore the external temperature must be best suited to internal tissues(1) and relatively narrow ranges of temperature change may cause harm or death. Tropical and subtropical fish and marine forms are more stenothermal (tolerate a narrow range of temperature) than are fish of the higher latitudes or fresh water forms(1). In tropical areas species live close to their thermal limits and effects of heated effluents are more pronounced(1).

The effect of temperature is well established on other organisms as well as fish. This includes both flora (algae, etc.) and benthic (bottom dwellers) forms.

The effects on all organisms in an aquatic community are important because of the inter dependence of the species. For example, temperatures which are not lethal to fish or shell fish may affect metabolism, reproduction and growth, as well as reduce important food organisms, thereby inducing a change in the entire balance of the system.

In conclusion, all aquatic life is directly effected by temperature changes and outside a certain range the change may be harmful, either to the fish or benthic organisms or to the food chain supporting each.

SOURCES OF HEATED WATER

Many industries utilize water to cool equipment used in the manufacturing process. This water is discharged from the industry several degrees warmer than when it was taken in, except where water cooling facilities are utilized. The electric power generating industry accounts for about 80 per cent of the cooling water used throughout the nation. Present and future demands for power, accompanied by the increasing demands for supplies of cooling water as well as a place to dispose of waste heat, is a serious problem.

The generation of electric power requires a heat source such as the combustion of coal oil or gas or heat produced by a nuclear reactor. The heat produced is utilized to make steam which drives turbine generaters. The steam is condensed and returned to the boiler system. Condensation of the steam is carried out in cooling coils which are cooled by condenser cooling water orginating either from a natural water course or supply or from an enclosed cooling water system.

The enclosed cooling water system does not present a significant thermal pollution problem, because there is little or no discharge.

Condenser cooling water obtained from a natural water source (river, well, bay) and discharged without adequate cooling of the heated water can cause thermal pollution problems. This is usually called single pass cooling.

Such heated condenser water may be cooled by several methods, prior to discharge. These methods include cooling towers, either dry or wet (evaporative) including either forced draft or natural draft, cooling ponds or reservoirs, and by dilution of the heated water by cool water from the same source.

Some general factors to consider are:

1. The overall thermal efficiency of power plants are:
    (1) Fossil Fuel Plants - approximately 33 - 40%.
    (2) Nuclear Plants - approximately 33%. (This means that of the heat input, only the % shown is usable electricity.)
2. Waste heat discharged from:
    (1) Fossil Fuel Plants (40% efficient) Approximately 3800 BTU/KWH.
    (2) Nuclear Plant (33% efficient) Approximately 6400 BTU/KWH.
3. The range of temperature rise of the cooling water is 10 - 20° F. with an average of 15° F. Water required at a 15° rise is from 30 to 55 gallons per KWH.
4. For a 2,384,000 KW plant such as proposed at Turkey Point the water required is about 48 GPM per per KWH or 2,750,000,000 gallons per day.
5. Some comparative costs of cooling water systems (2):

Type of System	Investment costs $/KW Fossil Fuel	Investment costs $/KW Nuclear
Single Pass	$2.00 - 3.00	3.00 - 5.00
Cooling Ponds	$4.00 - 6.00	6.00 - 9.00
Wet Cooling Towers:		
Mechanical Draft	$5.00 - 8.00	8.00 - 11.00
Natural Draft	$6.00 - 9.00	9.00 - 13.00

NOTE: Operating costs are higher with towers.

FLORIDA POWER AND LIGHT OPERATION

Florida Power and Light presently is operating two fossil fuel generating units at Turkey Point south of Miami in Dade County. The first unit went into operation on April 22, 1967, and the second unit began operation on April 25, 1968. These two units each provide 432,000 kilowatts of electricity and discharge some 635 cubic feet per second, or 285,000 gallons per minute, of cooling water which is about 10 degrees warmer than normal bay water temperatures.

Because of the increasing demand for electrical power, the company announced on November 15, 1965, the construction of two 760,000 kilowatt nuclear units at Turkey Point. The plan has been cleared by the Atomic Energy Commission and the Dade County Metro Commission as to rezoning, and on April 29, 1967, construction began on the two units. Each of these two units will discharge approximately 1,490 cubic feet per second, or 670,000 gallons per minute, of cooling water at approximately 15 degrees F. above the normal bay temperature. The operation of the two units (units 3 and 4) has not yet been approved by the Dade County Pollution Control Department, the Florida Department of Air and Water Pollution Control, or the Federal Water Pollution Control Administration.

There is evidence that the present operation at Turkey Point has damaged the bay. In fact, marine plants and some marine invertebrates were killed on June 28, 1969, in an area of Biscayne Bay extending about 1,000 yards from the point of hot water discharge.

The kill was detected about the morning of June 27, two days after temperatures were increased by a discharge of heated water. Maximum bay water temperatures of 100 degrees F. to 103 degress F. were recorded on June 25, some 300 yards from the discharge point.

Florida Power and Light's two units are presently operating under a Variance issued under Date County regulations which allow a maximum not to exceed 95 degrees F. The Variance was valid until July 31, 1969, and has been extended to October 1, 1969. At the State level, an exception to the regulation was adopted November 7, 1967, by the Florida Air and Water Pollution Control Commission pending completion of biological studies by University of Miami and an evaluation of those studies. In addition, water quality studies continue to determine the basis for a numerical level to be applied to thermal pollution regulations. Studies are being conducted by Federal Water Pollution Control Administration, Florida Department of Natural Resources, Division of Game and Fresh Water Fish and Division of Marine Resources, and Department-of-Health and Rehabilitation Services.

3. Spray ponds -- Spray ponds might be used in conjunction with ordinary cooling ponds with effectiveness.

4. Cooling lakes or large cooling ponds -- There are three major questions. (a) The problem of salt water intrusion apparently has not been carefully evaluated. (b) There is a question of the validity of the company's claim of detrimental effects on the local ecology by the destruction of 3,000 acres of mangrove. The greatest part of the mangrove area in which such ponds would be installed is presently cut-off from the surrounding environment by large canals to the north and south, and by other canals and the plant to the east and the salt water barrier to the west. Therefore, the contribution of nutrients to the environment from this mangrove area is questionable since the natural exchange with the surrounding aquatic environment has been cut-off. (c) The third company objection --- loss of effectiveness during calms or periods of high humidity --- seems doubtful because the area is subjected to almost constant air movement and a dilution system could augment the cooling upon failure of the ponds to perform adequately.

5. A pipeline to the ocean -- This would be a high-cost installation, would require a right-of-way, and possibly, would be difficult to maintain. However, the construction of a pipeline would remove the problem completely from the nearshore waters and, if it were properly constructed, would cause no further damage. In addition, the company will probably wish to expand in the future, therefore the company could design the pipe to accommodate future water demands.

The most recent proposal, made June, 1969, by the company, is to discharge the heated cooling water through a canal to Card Sound some 5½ miles south of the present discharge point. The proposal includes the use of 100 per cent dilution by water from the bay to provide a 94 degree F. discharge. This decision to discharge to Card Sound appears, almost entirely, to be a means to avoid recirculation of warm water from the present discharge point to the cooling water intake point. The recirculation of warmer water to the intake point was the major point of a study done by the University of Florida under the sponsorship of Florida Power and Light. It is the author's opinion that the major reason for this current proposal is not conservation or pollution control, but to avoid recirculation of heated water, which would lower plant efficiency and increase operating cost.

The company's present proposal calls for the discharge of 94 degree F. water except for about 4 per cent of the year when the 94 degree figure will be exceeded. The highest temperature expected to be experienced is about 98 degrees F. However, one-half of the four per cent will occur during August, when an estimated 175 hours of higher temperatures are expected. Assuming the occurrence of temperatures above 94 degrees F. to last only for a period of six hours (during hot part of the day), this condition could occur 29 days during August, or 94 per cent of the number of days in August.

A report, "Temperature Studies of Lower Biscayne Bay, Florida", by the Federal Water Pollution Control Administration, issued in October, 1968, shows that the maximum environmental bay temperature (short term) was 90 degrees F. in August, 1968. The maximum daily average of 88 degrees F. occurred two days at one "background" station. From plant design and calculations, Florida Power and Light is assuming a maximum bay temperature of 39 degrees for August, which is the critical month with regard to power production and cooling water availability, as well as temperature rise in discharged cooling water. The thermal pollution regulation for Dade County allows a maximum of 95 degrees F.

This proposal, using the design figure of 89 degrees, and an average temperature rise for cooling water of 12 degrees, would not comply with the Dade regulations. However, the proposal includes that the necessary cooling will be accomplished by the use of bay water, with quantities up to an amount equal to the discharge rate of the condenser. This is to dilute and cool the condenser water to a temperature of 95 degrees. Subsequent cooling of one degree is provided in the proposed canal to result in a final temperature of 94 degrees F., which is within the Dade County maximum.

TEMPERATURE LEVELS RELATIVE TO AQUATIC LIFE

Data on the effects of temperature on aquatic life is included in the "Report of the Committee on Inshore and Estuarine Pollution" sponsored by the Hoover Foundation. Members of the committee were 10 persons (see attached list) recognized as being outstanding in the field of marine science. While there has been much discussion on the effects of thermal discharges in the last several years, this is the only document which discusses the problem of thermal pollution in a tropical environment. The report was an extensive literature study, and the recommendations made are the opinions of the committee based on the literature surveyed.

Seven recommendations were made. The most important is that the "maximum permissible temperature at the outfall must not exceed 90 degrees F.". In addition, the report recommends monthly temperature limits throughout the year ranging from 70 to 90 degrees F. The report contains several statements, two of which are considered here: (1) The fact that adults of some organisms (fishes) are often observed in (areas?) patches of warm water in the cooler months does not indicate that warm water as such contributes to the welfare of the species as a whole. (2) Adults of a number of tropical marine organisms in widely divergent groups of plants and animals all survive to a temperature of about 82 degrees, reduce their metabolism between 82 and 86 degrees, and begin to show a distinct drop in activity at about 88 to 90 degrees. They begin to die above 91 or 93 degrees F. Included in this group of plants and animals are algae, phytoplankton, mosquitoes, shrimp, sea urchins, coral, sea fans, crabs and marine fishes. Exceptions do occur where organisms die below 90 degrees F., but the concensus of the literature indicates that 90 degrees is a critical point in biological systems and should not be exceeded. These conclusions are based upon laboratory and field investigations by many investigators. Some estuarine larvae, such as shrimp and killfish, can tolerate temperatures up to 97 degrees F., but these groups are exceptions.

The report also states, to sum up, that adult organisms in Biscayne Bay are living in the summer in water which is within a degree or two of their upper lethal limits, and cannot be acclimatized to higher temperatures. It notes further, that temperature oscillations are needed for normal operation of life processes.

It would appear then, that not only is it necessary to impose maximum temperature limits, but that it is necessary to maintain seasonal temperature fluctuations. Therefore, the committee included a maximum temperature for each month based on normal seasonal temperatures.

The establishment of a numerical maximum of 90 degrees F., as indicated in the "Hoover Report" would equal the 90 degrees F. maximum recorded in Biscayne Bay in 1969. In addition, data taken at other locations in Florida indicate natural temperatures higher than 90 degrees F.

Reference to the appended lists of Temperature Standards, it is noted that maximum temperatures do not exceed 97 degrees F. Most of the maxima are in the 93 to 95 degree F. range. It is notable that the Virgin Islands has a 93 degree F. maximum temperature with a maximum rise above natural conditions of 4° F. during the fall, winter and spring and 1.5 degrees F. during the summer. This, of course, is in a tropical zone and is consistent with the Federal "Water Quality Standards" proposed by the Technical Advisory Committee.

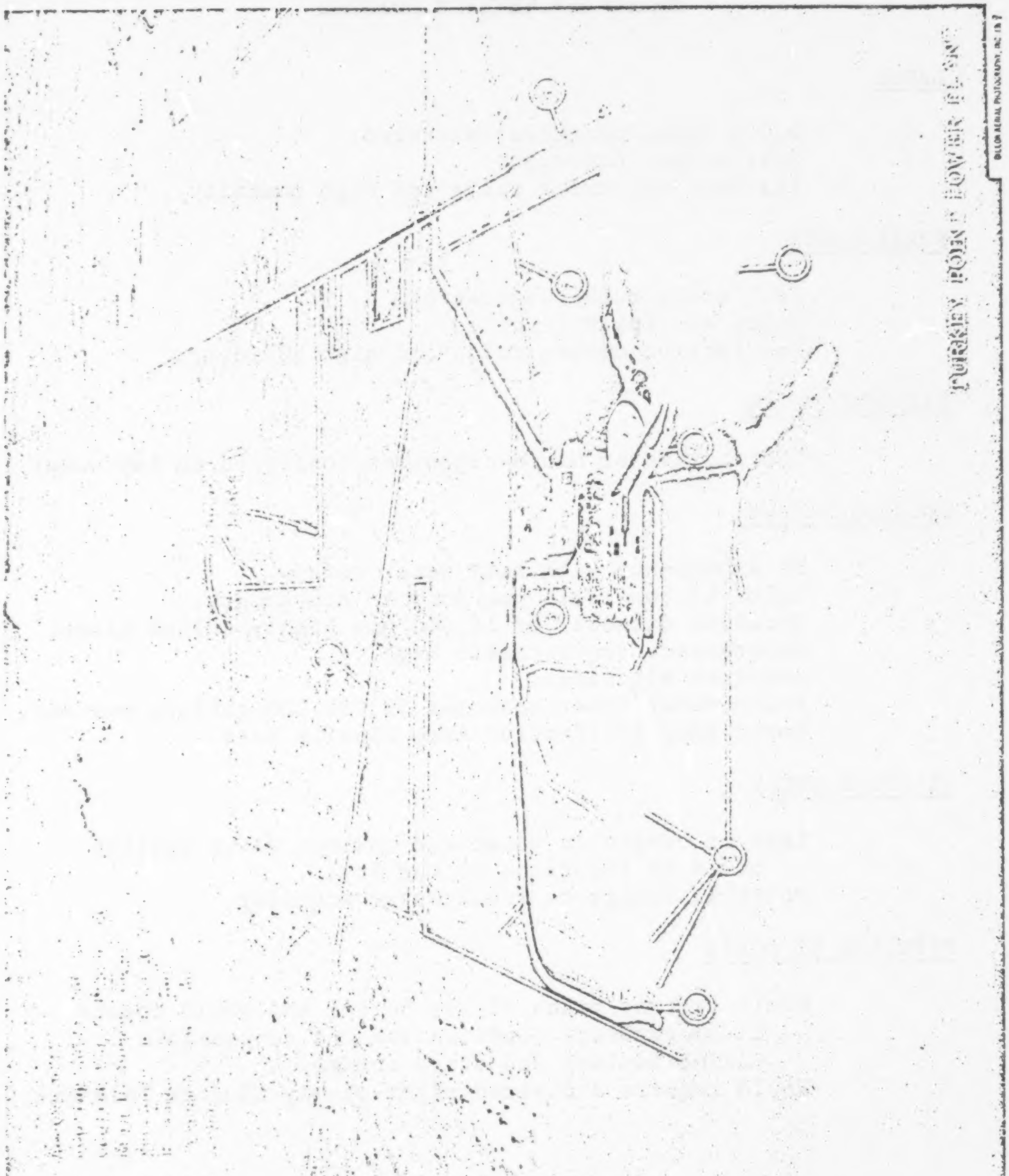
CONCLUSIONS

1. The present plant operation has been shown to be in violation of Florida's "no damage" clause Chapter 28-505(2)(g), as shown by Federal Water Pollution Control Administration's data during June, 1969.
2. The company's proposal of June, 1969, is not adequately supported by data confirming the method chosen or data confirming protection of the bay ecology.
3. The 94° F. maximum presently proposed (for the month of August) is 5° above the ambient bay temperatures and probably will not adequately protect the marine ecology.
4. The rise above 95° F., 4% of the time is an additional factor which supports the probability of damage to the ecology and that the temperature will not comply with Florida rules which state that "temperature shall not be increased so as to cause any damage or harm to the aquatic life or vegetations".
5. Based on the best available information, the maximum temperature at the discharge point should not exceed a 2° F. to 3° F. rise above natural temperature.
6. Cooling ponds in addition to dilution water should be thoroughly investigated to determine feasability. Cooling ponds aided by the addition of dilution water can meet the 2° to 3° F. rise.
7. Discharge of the heated cooling water to the ocean by means of a pipeline should be seriously considered.

8. A discharge to Card Sound rather than Biscayne Bay has minimum value as an antipollution measure and the relative damage elements have not been fully assessed.

ADDENDA

Page Number	Content
1.	Aerial view of plant showing property lines and other major factors. (Figure 3 of Florida Power and Light Report).
2.	Alternate cooling methods (Figure 11 of Florida Power and Light Report).
3.	Proposed discharge conditions (Figure 12 of Florida Power and Light Report).
4.	Map showing predicted temperature field (Figure 13 of Florida Power and Light Report).
5.	List of Committee Members preparing "Hoover Report".
6.	Temperature Standards - Federal, Dade County.
7.	Temperature Standards - Florida and seven other Southern US States and two Territories.
9.	Tabulation of Temperature Standards (From Federal Power Commission Report 1969).



TURKEY POINT POWER PLANT
DILLON AERIAL PHOTOGRAPHY, INC 1967

FIGURE 3

Reproduced from best available copy.

ALTERNATE COOLING METHODS

LAKES

3,000 acres mangrove destroyed.
Salt water intrusion.
Ineffective during calms and high humidity.

SPRAY PONDS

Salt drift ruins vegetation.
Miles of piping required.
Ineffective during calms and high humidity.

DISPOSAL WELLS

Destructive of micro-organisms contained in Bay water.

COOLING TOWERS

No experience with salt water towers.
Emits 46 tons salt per hour to atmosphere.
Requires disposal of 18,000 gpm highly saline water.
Maintenance requirements high.
Requires algacides.
Fresh water tower consumes 55,000,000 gallons per day.
Would make ineffective Army Missile Base.

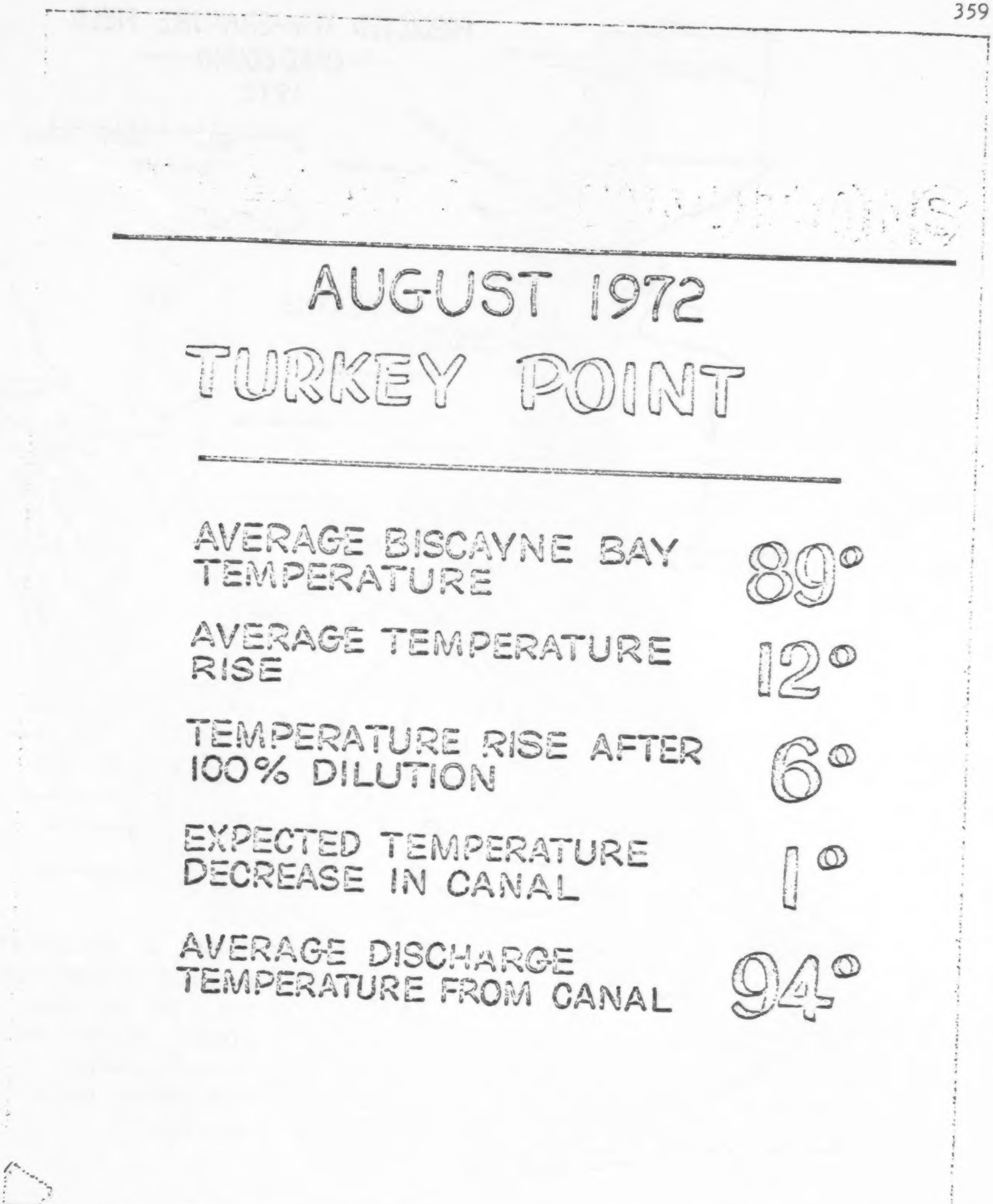
DILUTION WELLS

Lack of oxygen in water and unknown water quality could be injurious to the Bay.
Possible damage to fresh water acquifer.

PIPELINE TO OCEAN

Would destroy miles of Bay bottom and would create an operational complication due to possible marine fouling and storm damage.
Would require a cleared right-of-way through Islandia.

FIGURE

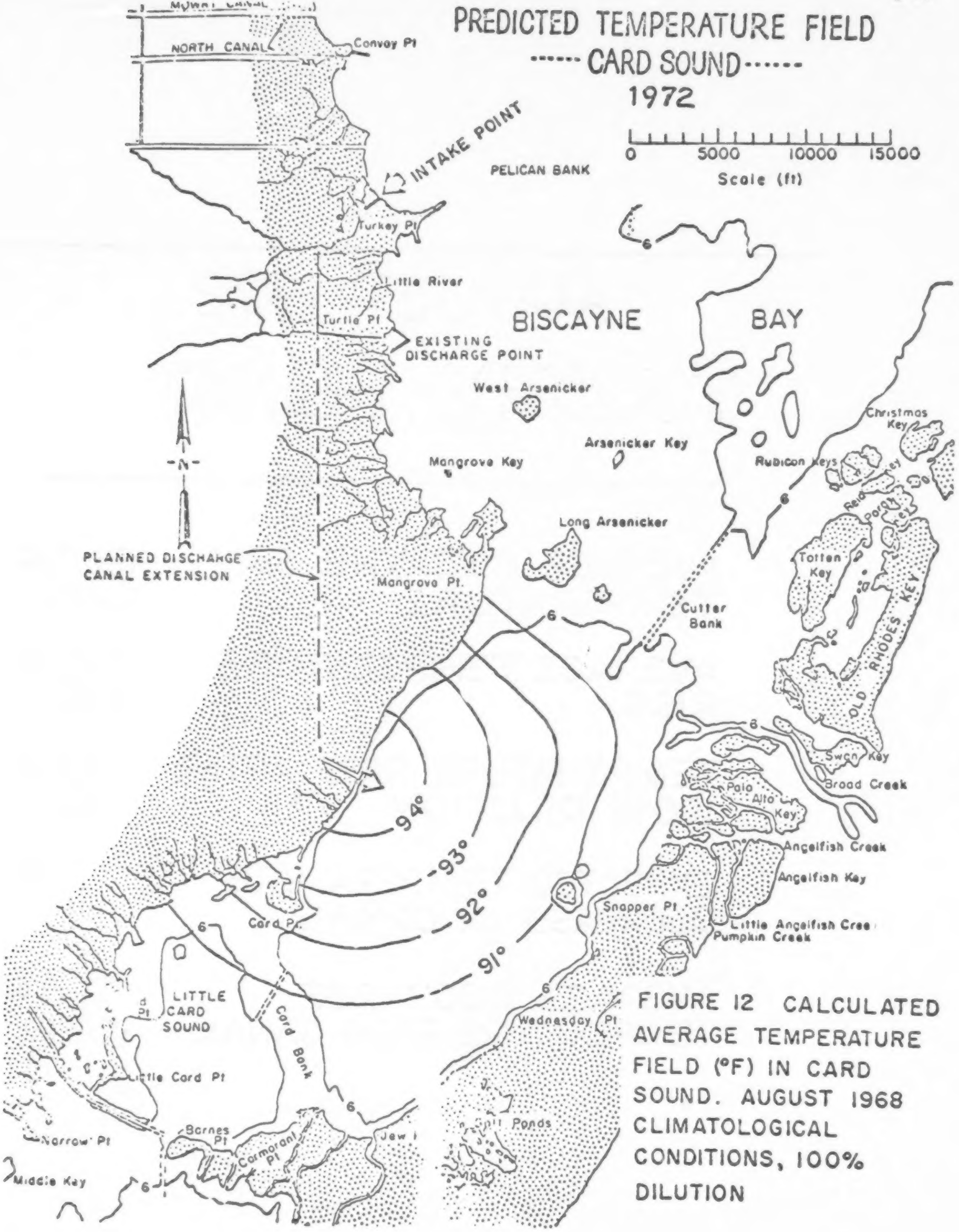


AUGUST 1972

TURKEY POINT

AVERAGE BISCAYNE BAY TEMPERATURE	89°
AVERAGE TEMPERATURE RISE	12°
TEMPERATURE RISE AFTER 100% DILUTION	6°
EXPECTED TEMPERATURE DECREASE IN CANAL	1°
AVERAGE DISCHARGE TEMPERATURE FROM CANAL	94°

FIGURE 12



PREDICTED TEMPERATURE FIELD
------ CARD SOUND ------
1972

MOWRY CANAL
NORTH CANAL
Convoy Pt
INTAKE POINT
PELICAN BANK
0
5000
10000
15000
Scale (ft)
Turkey Pt
Little River
Turtle Pt
EXISTING DISCHARGE POINT
BISCAYNE
BAY
West Arsenicker
Arsenicker Key
Mangrove Key
Rubicon Keys
Christmas Key
Reid Key
Porgy Key
N
PLANNED DISCHARGE CANAL EXTENSION
Long Arsenicker
Totten Key
Mangrove Pt.
Cutter Bank
OLD RHODES KEY
6
94°
93°
92°
91°
Swan Key
Broad Creek
Palo Alto Key
Angelfish Creek
Angelfish Key
Snapper Pt
Little Angelfish Creek
Pumpkin Creek
Card Pt.
LITTLE CARD SOUND
Card Bank
Wednesday Pt
Little Card Pt
Barnes Pt
Cormorant Pt
Jew
Salt Ponds
Narrow Pt
Middle Key

FIGURE 12 CALCULATED AVERAGE TEMPERATURE FIELD (°F) IN CARD SOUND. AUGUST 1968 CLIMATOLOGICAL CONDITIONS, 100% DILUTION

FIGURE 13

Members of the Committee

Dr. Gilbert L. Voss, Professor of Marine Science and
Chairman, Division of Biology,
Institute of Marine Sciences.

Dr. John S. Bunt, Professor of Marine Science and
Chairman, Division of Functional Biology,
Institute of Marine Sciences.

Dr. Donald P. de Sylva, Associate Professor of Marine Science,
Institute of Marine Sciences.

Dr. Walter Drost-Hansen, Professor of Chemical Physics and
Chairman, Division of Physical Oceanography,
Institute of Marine Sciences.

Mr. Hans Frohlich, Associate Professor of Mechanical Engineering,
Institute of Marine Sciences.

Dr. Walter A. Glooschenko, Assistant Professor,
Department of Oceanography,
Florida State University.

Dr. Hilary B. Moore, Professor of Marine Science,
Institute of Marine Sciences.

Dr. Maurice W. Provost, Director, Florida State Board of Health,
Entomological Research Center.

Dr. C. Richard Robins, Professor of Marine Science,
Institute of Marine Sciences.

Dr. Durbin C. Tabb, Associate Professor of Marine Science,
Institute of Marine Sciences.

TEMPERATURE STANDARDS

FEDERAL - "Water Quality Criteria"-"Report of the National Advisory Committee to the Secretary of the Interior April 1968".

Recomended Standards

Protection of Marine and Estuarine Organisms.

Temperature: "Monthly means of the maximum daily temperatures recorded at the site in question and before the addition of any heat of anticipated origin should not be raised by more than 4°F during the fall, winter and spring (September through May) or by more than 1.5°F during the summer (June through August). The rate of temperature changes should not exceed 1°F per hour except when due to natural phenomena. Suggested temperatures are to prevail outside of established mixing zones as described in the section of zones of passages."

Statement also includes definition of summer and winter for northern waters.

Protection of Fresh Water Organisims.

Temperature should not be raised more than 5°F. Epilimnion (lakes and resevoirs) not to be raised more than 3°F. Maximum temperature recommeded for various fresh water fish species. Includes recommendations for cold waters.

Dade County

Waters not to exceed 95°F.

TEMPERATURE STANDARDS

STATE

FLORIDA - Temperature - shall not be increased so as to cause any damage or harm to the aquatic life or vegetation of the receiving waters or interfere with any beneficial use assigned to such waters.

NORTH CAROLINA - Temperature Standards approved by Secretary of Interior except 95° Maximum

Class A I - None
All other Classes - Not to exceed 7°F rise, no case exceed 95°F. Trout waters not exceed 70°F.

TENNESSEE - Temperature standards approved by Secretary of Interior - except 10°F rise.

1. Domestic water supply - not exceed 93°F at maximum rate of 3°F per hour.
2. Industrial water supply - not exceed 93°F at maximum rate of 3°F per hour.
3. Fish and Aquatic Life - not exceed 93°F at maximum rate of 3°F per hour with maximum of 10°F rise. Includes maximum 68° for trout streams.
4. Recreation - not exceed 93°F.
5. Irrigation - not interfer with use
6. Livestock Watering and Wildlife - not interfer with use.
7. Navigation - not interfer with use

Note: 93°F results from adding 5° to surface temperature of 88°.

TEXAS - Approval by Secretary of Interior not known.

All Waters - 96°F maximum with maximum rise 5° except Canadia River and tidal waters
Canadian River - 93°F maximum with maximum rise 5°
Tidal Waters - 4°F maximum rise - summer

LOUISIANA - Approved by Secretary of Interior not known.

All Waters - *36°C (97°F) maximum or 3°C(5°F) maximum rise - some rivers limited to 35°C maximum or 2°C maximum rise
*includes coastal waters

GEORGIA - Secretary of Interior - must be reviewed

All waters, classes 1 through 6 - maximum 93.2°F (34.0°C), maximum rise 10°F except trout streams 0°F rise.

ALABAMA - Temperature criteria excepted by Secretary of Interior
Class 1 through 5 waters - maximum 90°F, maximum rise not exceed 10% - except may be 93°F for 8 hours during 24 hours.
Class 6 and 7 waters - None

Addendum for Classes 1 - 5
"With respect to cooling water discharges only, the ambient" - maximum rise not more than 10°F, not to exceed 93°F.

CALIFORNIA - Temperature excepted by Secretary of Interior
Recommended Thermal Objectives
Most Rivers - no heat shall be added to these waters which will cause the water temperature to exceed - historical temperatures.

Some Rivers - same as above except not more than 2°F rise per single discharge and no accumulation.

Goose Lake - not to exceed 70°F or daily mean ambient temperature.

Lake Tahoe - The addition of heat is prohibited

Coastal Waters - no thermal objectives except, - proposed objectives - no increase beyond plume or limited dilution area.
Proposals to be reviewed individually
Each potential source required to conduct pre and post installation studies.

Proposed discharges are required to demonstrate the innocousness of their proposed discharges by detailed ecological studies of receiving waters covering at least one year of pre discharge and one year of post-discharge condition.

VIRGIN ISLANDS - Approved by Secretary of Interior

Class A - Preservation of Class A-no temperature change

Class B - Propagation of Marine Life and Water Contact Recreation - Not to exceed 90°F or more than 4°F above natural during fall, winter, spring nor 1.5°F during summer.

Class C - Harbors and Docking Facilities - Propagation of Marine Life and Water Contact Recreation - not to exceed 90°F or more than 4°F above natural during fall, winter, spring nor 1.5°F during summer.

PUERTO RICO - Approved by Secretary of Interior
All surface waters are considered Public water supply - Temperature not increased more than 5° and in no case 93°F.

Coastal Waters -
Class SA - Preservation of existing natural phenomena - temperature maintained natural levels.

Class SB - Growth of shell fish - temperature not more than 4°F above ambient or in no case exceed 93°F.

Class SC - bathing - no case exceed 93°F

Class SD - Propagation of marine life - no case exceed 93°F

Class SE - for industrial usages - no case exceed 93°F

Table 4

Limiting Temperature Criteria in Water Quality Standards for Interstate Waters 1/

States and other Jurisdictions	Limiting Uses 2/														All Waters		Exceptions & Remarks
	Cold Water Fish		Smallmouth Bass		Warm Water Fish		Fish & Shellfish		Recreation		Water Supply		Industrial				
	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	
Ala.															90	10%	Temp. may reach 93° for 8 hrs. per day. Not approved for shellfish or fish and wildlife uses.
Alas.					60	5%	68				60		70				Salt water.
					60	10%					60		70				Fresh water; 0.5% allowed if nat.temp. greater than 60°.
Ariz.	55				93	5											November-March.
	70	2			93	5											April-October.
Ark.	65	5	86	5	95	5											
Cal.																	Not approved. Allowable temperatures vary with stream and location.
Colo.	70				90								93				
Conn.												0			85	4	
Del.															75	5	Ocean.
																5	Most streams.
															85-87	5	Some streams.
D. C.															90	5	
Fla.																	Shall not interfere with beneficial uses assigned to waters. Numerical criteria will be assigned following 1-year study.
Ga.		0					93	10	93	10	93	10	93	10			
Haw.																1.5	
Ida.															68	2	Except Snake-R.M.407-247, Max. 70°, rise 2°.
Ill.					60	5							90	5			December-March.
					90	5							90	5			April-November; open waters have max.temp. of 85° and 5° rise.
Ind.	65	9			93	9							95	9			April-Nov.
		9			60	9											Dec.-March - Above 65° allowed for coldwater fish if oxygen content greater than specified; 85° max. for Lake Michigan.
Iowa															89	5	Miss. River-From Minn. to Wisc.-Ill. border.
															90	5	-From Wisc.-Ill. border to Mo.border.
															90	5	Mo. River-May-October.
																10	-November-April.
															93	10	Other streams-not approved.
Kan.															90		Not approved.
Ky.															93	10	March-Nov.; (not approved)
															73	10	Dec.-Feb.
La.															97	5	Except some rivers with 95° max. and 4° rise.
Me.	68	4			83	4							90				Temp. standards not approved.
Md.	72				60	20											Nat. temp.less than 50°.
	72				93	10											Nat. temp.more than 50°; 90° max. for tidal.
Mass.																0	Class A.
	68	4		4	83	4		4		4		4	90				Others.
Mich.	70	10			85	10			90			10		10			Aquatic life temps. not approved. 15° rise allowed for warm water fish if original temp. is below 36°.
Minn.		0		0		0				0			75				Class 2A & 3A; "2" refers to Fisheries & Recreation.
					86				86				86			5	Class 2B & 3B; "3" refers to Industrial Uses.
					90				90				90			5	Class 2C & 3C.
Miss.															93	10	10° rise not approved.

Table 4 (Continued)
Limiting Temperature Criteria in Water Quality Standards for Interstate Waters 1/

States and other Jurisdictions	Limiting Uses 2/														All Waters		Exceptions & Remarks
	Cold Water Fish		Smallmouth Bass		Warm Water Fish		Fish & Shellfish		Recreation		Water Supply		Industrial				
	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	
Mo.															90	5	Except Des Moines where max. temp. is 93° and except North Fork White, Current, and Eleven Point Rivers where max. rise is 2°.
Mont.	69	2			89	4								0			If orig. temp. is above 67° and 85°, 0.5° rise for fisheries.
Neb.	65	5			90	5				5		5					May-October.
	65	5				10				10		10					November-April; except for Mo. River from Gavins Pt. to Sioux City which is 85° max. and 4° rise for warmwater fish.
Nev.	68				86										 57		Summer.Some waters have Winter.summer max. of 64°-81°, other waters have summer max. avg. daily temps. of 55°-77°.
N. H.													90				Criteria for fish not approved.
N. J.																0	FW-1(preserve nat. conditions).
	70	5			87	5											5° refers to avg.temp.grad. occurring in 1961-66.
N. M.	70	2			93	5											10° rise allowed for lower reach of Pecos, which is not approved.
N. Y.		0			86	5											90° max. in mixing zone; 5° refers to permanent change.
								4									Sept.-May.
								1.5									June-Aug.
N. C.	70				95		95						95			7	95° max. not approved, 7° rise refers to fresh warm water fisheries only.
N. D.															90		90° max. & 10° rise for Red River of the North - Not approved.
Ohio	70				93												April-Nov. [Class A]]Not
	70				60												Dec.-March]ap-
	70				95												April-Nov. [Class B]]proved
	70				73												Dec.-March
Okla.	70	5	75	5	93	5											
Oreg.															64	2	Generally.
															70	2	Multnomah Channel, Willamette, Snake.
															68	2	Columbia, Grande Ronde, Walla Walla.
															72	2	Klamath River.
																0	Marine water.
Pa.	58	5			87	5											86° max. Delaware Estuary, 93° max. in Mahoning.
R. I.																0	Class A(preserve natural conditions).
	68	4			83	4							90			4	Class B & C.
S. C.															93	10	Fresh waters; 10° rise not approved; 93° max. approved only for Savannah, Tugaloo, & Chatuge Rivers.
																4	Salt waters, winter.
																1.5	Salt waters, summer.
S. D.	68	4	75-85	4	90	8											
Tenn.															93	10	Not approved for fish & wildlife uses.
Tex.															96	5	Except Canadian & tidal waters.
															93	5	Canadian River.
																4	Fall,winter,spring-tidal waters.
																1.5	Summer -tidal waters.
Utah	[illegible]	2			80	4											

Table 4 (Continued)

Limiting Temperature Criteria in Water Quality Standards for Interstate Waters 1/

States and other Juris-dictions	Limiting Uses 2/														All Waters		Exceptions & Remarks
	Cold Water Fish		Small-mouth Bass		Warm Water Fish		Fish & Shell-fish		Recreation		Water Supply		Industrial				
	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	Max. Temp.	Max. Rise	
Vt.	68				83	4							90				68° not approved; no increase for Class A waters.
Va.					95												Not approved.
	70																Temp. rise criteria to be added within 1 yr. No thermal barriers to fish passage. No change for essential spawning areas.
Wash.															60	75/T-22	Fresh,Class AA;T=Resulting water temp.
															55	24/T-39	Marine,Class AA
															65	90/T-19	Fresh, Class A
															61	40/T-35	Marine, Class A
															70	110/T-15	Fresh, Class B
															66	52/T-32	Marine, Class B
															75	125/T-12	Fresh, Class C
															72	64/T-29	Marine, Class C
W. Va.															93	5	May-Nov.
															73	5	Dec.-April; specific temps. are set for most streams.
Wisc.					89	5							89				84° max. where maintenance of fish reproduction is of primary importance.
Wyo.		2															Where nat. temp. less than 70°.
		4															Where nat. temp. greater than 70°.
Guam								1.5	85		85	5					
P. R.																0	Class A.
															93	4	Other waters.
V. I.																0	Class A.
															90	4	Fall,winter,spring; 1.5° rise in summer.

1/ The water quality standards proposed by all states and other jurisdictions have been approved by the Secretary of the Interior, although some approvals were with reservations including reservations relating to temperature criteria. The temperature criteria shown have been approved by the Secretary except as noted.

2/ Temperature criteria for most states include general restrictions which limit the effects of increase to those conducive to the limiting use of the water body. Classes are designated by the individual state involved and are not necessarily comparable with other states.

Reproduced from best available copy.

MR. STEIN: Thank you, Mr. Patton. Any comments or questions?

I just have one. That is, if I understand this correctly, do you mean to say that Florida Power & Light has not formally submitted the plan for discharge or indicated whether it is going to meet the State requirements and standards to build that canal?

MR. PATTON: No, sir, they have not submitted a formal request.

MR. STEIN: And they have started to build the canal?

MR. PATTON: Yes.

MR. STEIN: Well, I'll tell you, we used to have this kind of operation throughout the country. Industrialists would build plants and start discharging, but I haven't heard of that recently. At that time, industrial firms would move ahead and start construction without a permit.

Maybe there is a reason for this. If there is, I'd like to hear it. But just offhand this seems like a throwback to twenty years ago.

MR. PATTON: I can't answer your question.

MR. STEIN: All right. Any other comments or questions? If not, Mr. Reed.

Paul W. Leach

MR. REED: I'd like to call Paul W. Leach, Director, Dade County Pollution Control, Dade County, Florida.

PAUL W. LEACH, DIRECTOR,
DADE COUNTY POLLUTION CONTROL,
MIAMI, FLORIDA

MR. LEACH: Mr. Chairman, first, let me say that we agree with you that there is and has been damage done to Biscayne Bay off of Turkey Point. However, the action which I have taken in approving the construction of facilities for cooling the water from the Turkey Point facility will forever remove that threat to Biscayne Bay and, therefore, the only question to be considered here today is: Is the system which has been approved safe, practical and economical?

It is my feeling that any system proposed or considered which is not tied in with the presently approved canal to Card Sound is merely assuring the eventual destruction of the ecology of that part of Biscayne Bay and the Biscayne National Monument, for any system installed will require that a discharge must take place and that discharge must be placed somewhere.

We have evaluated each available system in all its facets in drawing this conclusion.

Systems Considered

1. There is no question that, if a closed circuit cooling tower could be operated properly, it would be the most beneficial solution to the interests of Seadade Industries, through whose property the canal will pass. A closed circuit cooling tower, however, cannot function with salt water since the salt concentration would eventually reach disastrous proportions unless nonsaline makeup water in the amount of 180 million gallons per day is added to the system. Drawing off this much freshwater from the Biscayne Aquifer each day is totally unacceptable.

2. Therefor, the only alternative available using towers, would be to use a once-through cooling tower with a discharge through the present canal system into Biscayne Bay and the Biscayne National Monument. Our technology in this area has shown us that such towers are at best, highly experimental, and considering the probability of breakdown, which would most likely occur under the most intense operating conditions, the discharge of the uncooled effluent would enter Biscayne Bay with disastrous results.

3. Another alternative is to carry the entire heated effluent across Biscayne Bay to the ocean through a very expensive pipeline. Such a proposal, as has been made previously, was offhandedly rejected from any consideration by Mr. Nathaniel Reed, representing the State of Florida, and by Mr. James Redford, a local conservationist. There is no question that this alternative would cost as much as 8 to 10 times the capital investment of the presently approved system.

4. A fourth alternative is the dredging of immense cooling ponds. These cooling ponds would have to be some 2,000 to 3,000 acres in surface area and such cooling ponds would have to be dredged either landward, thereby infiltrating the freshwater supply of this area by salt water, or by dredging and diking in Biscayne Bay, itself. This solution is totally unacceptable in either of these configurations.

5. The final alternative available, therefore, is the one selected by the Pollution Control officer, and that system must be considered here today.

CONCLUSIONS and RECOMMENDATIONS

It is my recommendation to you that you endorse this finding which has already been reviewed by the Dade County Pollution Control Hearing Board, a panel of five well-qualified scientists, who have a personal interest in the preservation of Biscayne Bay and the Biscayne National Monument. They are members of this community with its interest in mind.

Additional safeguards have been made in this plan for dilution during high temperature periods, as well as for a continuing study which would indicate if ecological damage was imminent before it occurred.

Under the provision of the permit which has been issued, there are several options open for requiring immediate corrections so that no ecological disaster would take place.

I might point out, in going away from the prepared statement, that when we took over this operation in Dade County, the enforcement of these regulations, we were already presented with this system already approved, approved by the State agencies, and it was necessary for us to look for the best minds under the present circumstance with the site which had been selected.

It is my feeling and my recommendation to you that you not criticize the Florida Power & Light Company for their future planning, but instead, commend them for it. If this company is due any criticism, it is only for their short-sightedness in permitting the present inadequate system to continue for as long as it has.

MR. STEIN: Thank you, Mr. Leach.

Are there any comments or questions?

Maybe I don't understand it. I have read the statement. I think I'm familiar with State laws in water pollution control. Doesn't the State have the requirements of permits?

MR. LEACH: No.

MR. STEIN: They don't?

MR. LEACH: The Dade County Pollution Control Ordinance sets up the only permit requirements.

MR. STEIN: You don't recognize that the State has a requirement of a permit for discharge of water in the State of Florida?

MR. LEACH: There has been up to this date, to my knowledge, no State permit requirements.

MR. STEIN: I can tell you this. I read the Florida law, and unless Mr. Reed or Mr. Patton wants to correct me, I think that Florida is like any other State that requires a State permit.

And I will tell you, Mr. Leach, I have been coming down here for years, and for the first time I'm beginning to have an understanding of why Miami has the sewage treatment plants they have.

You don't think the State has a requirement for a permit?

MR. REED: The last session of the legislature stated that the State has that authority. The Board has passed on that, and it is filed before the Secretary of State, and then it will become law. Before they can discharge water in navigable waters in Florida they are required to have the approval of the Internal Improvement Board, which is coordinated by many different departments of the State of Florida, plus a Corps of Engineers permit.

MR. LEACH: The application and receiving of such permits is the duty of Florida Power & Light Company. It is necessary that they also receive permits from Dade County, which permit has been granted.

At this point, if they wish to proceed, so long as they do not violate State law, which they by proceeding have not done, it is not our intention to block that action.

MR. STEIN: I think you switched your position. You say it is not your intention to block the action. If they complied with the local permit, that's fine, but it seems to me, and I have dealt with every State in the union and in every major metropolitan area, and I will tell you in every major metropolitan area we may have this problem as a hangover, and I recognize the problem that you may have in Dade County because this isn't unique to you.

The point is that New York may have had a good regulatory program, but they always have the problem of regulating the big city, New York City. Massachusetts had the same problem with Boston; Illinois with Chicago; Pennsylvania with Pittsburgh and Philadelphia; Colorado with Denver -- you name it.

Since 1950, the big cities have recognized that the States have authority in water quality and water quality control, and they haven't gone off on their own without getting in line with the State.

In looking back at this, and I have been working in this field since 1948, and it seems to me I am seeing a rerun of a movie on the late-late show. Something that hasn't happened in this country for 20 years is being reenacted here. My suggestion is that we all try to get with it, and deal with the modern facts of life and responsibilities of the State, the Federal Government, and we hope to join with the cities and with Dade County and with Miami and the industries in preserving our water quality. But this notion of going it alone and just putting out the permit oblivious of anything, oblivious of what the State is doing, or the Federal Government is doing is what has gotten us into this pollution mess that we are all faced with today. I just can't understand it.

MR. LEACH: Mr. Stein, may I respond? We took over control in this area only in July of 1968. Prior to that the situation which you described as being ideal nationwide existed whereby the State issued all permits.

You mentioned the fact that Dade County is in a situation with the sewage treatment plants and the like, which has been well publicized nationally. I point out to you that we are in that position not by actions which have been taken since July of 1968, but by actions which were taken prior to that.

MR. STEIN: I think that we can all agree to that. If we had put all of our efforts in working at it since 1968, I don't think we would have achieved the situation that you have.

MR. LEACH: I fully concur. We do recognize the supremacy of law doctrine that you are presenting here. However, it is necessary that one agency take the first step to get something started.

As I mentioned to you, we are in this position not through our own efforts, but through the fact that these plans which were approved and permitted the construction of all four of these units prior to July of 1968, when we did take jurisdiction in this area, these plans were already approved. No system for cooling was ever considered.

MR. THOMAN: They were approved by whom, Paul?

MR. LEACH: By the Florida State Board of Health.

MR. STEIN: Mr. Leach, I would not in the operation of the Federal program propose that any industry in your jurisdaction receive our approval for any project unless it met your requirements, if they are more rigid than ours.

that. If we had put all of our efforts in working at it since 1968, I don't think we would have achieved the situation that you have.

MR. LEACH: I fully concur. We do recognize the supremacy of law doctrine that you are presenting here. However, it is necessary that one agency take the first step to get something started.

As I mentioned to you, we are in this position not through our own efforts, but through the fact that these plans which were approved and permitted the construction of all four of these units prior to July of 1968, when we did take jurisdiction in this area, these plans were already approved. No system for cooling was ever considered.

MR. THOMAN: They were approved by whom, Paul?

MR. LEACH: By the Florida State Board of Health.

MR. STEIN: Mr. Leach, I would not in the operation of the Federal program propose that any industry in your jurisdaction receive our approval for any project unless it met your requirements, if they are more rigid than ours.

Now, the point is with all the States and the citizens in the country we are trying to develop the State standards. I have been devoting a lot of time to this. We would hope that Dade County would work and give us the same accommodation and courtesy that we give you, Mr. Leach.

I would expect that if we are going to have really effective pollution control in this country, you have to recognize that this works two ways.

In Dade County, Miami or anywhere else, it has to tie in its requirements with the Federal requirements and the State requirements. The more we do that the less we are going to have need for a conference of this type, or hearings, and court actions, which are always very costly to everyone.

If we are really going to approach this program correctly, we all have to work together. I think the issue of setting up a tri-conference is an extremely difficult one. I think we have to recognize that.

I say this, and I hope in a constructive way. I think we have been through this with New York, Cleveland, possibly with Chicago, with Kansas City and

St. Louis. But this was done 15 years ago. I hope in this day and age we are not going to have to go through this minuet again down here; and the sooner we can get together and get the Federal, State and local people all respecting each other and respecting each other's requirements and standards, the better it is going to be for all of us, and the better for the constituents, and the municipalities within your area and your industries.

MR. LEACH: Mr. Stein, in responding to that, the Dade County Pollution Control Ordinance established in 1963 water quality standards, which are still as strict or stricter in every respect than those standards presently enacted by agreement between the State of Florida and the Federal Government.

The only area in which there may be any question is the statement on thermal pollution wherein the State standard there is a "no damage" clause tied in with a mixing zone; whereas in the Dade County law there is a definite 95° temperature limit with no mixing zone.

The question here is does damage occur at 95°? This was a matter for considerable lengthy months upon months of hearings before the Dade County Pollution Control Hearing Board in which many of the statements that you are hearing today were presented. They were taken into consideration by a board of qualified experts, qualified scientists, two PhD's in biology, two professional engineers, registered in the State of Florida, and one professional doctor in biochemistry.

Their decision was that there was not substantial evidence to prove that damage would occur, and, therefore, there was no reason not to consider moving forward with the plan which had been submitted.

MR. STEIN: I think I understood what you said. I am sure I did. But I think you have it wrong. You are working for clean water and clean environment just as we are. What you said really was, there is no place where you are not more stringent except on the issue of the question that's before us today, and that's why we are here.

Now, the second thing is that you heard the evidence, and the decision was made by representatives on the local level, not the decision of the State or Federal people. But you made the decision on your own. I am submitting to you, sir, I don't think that in the

Federal Government we have attempted to move this way, not since I came into this program. Maybe we were. However, I have been in it since 1948. In other words, before I tried to move I tried to get the acquiescence of the State and local unit of government, and I think our record will show in some 2,000 cities and 2,000 industries we have been in throughout the country, we have been able to achieve this.

I think we see the cause for environmental control and water pollution control when any one unit of government -- I don't care which one it is, Federal, State or local -- thinks it is going to make the move without going through the other or taking the effort to achieve it without the acquiescence of all others involved.

I think that method is something that we have to look forward to because that's the way we are going to make haste. We are not going to do it the other way, and I really think the point that you raised is a key point because unless we understand that, we are going to have a lot of trouble in the future.

I said this before. As far as I am concerned, I regard the Florida staff and our staff as one, and I don't see any difference. I think for this business of cleaning up this environment, this conceptualism of State's rights, Federal rights and local rights has no meaning whatsoever. We need all the help we are going to get, and we need your help, and we have to work out a program on which we are all going to agree. I had hoped we would get away from the notion that either we or you or the State is going to take unilateral action.

MR. THOMAN: Mr. Leach, let me point out something to you. Your Board took its action subsequent to the announcement of this Federal-State enforcement conference, and at one of the meetings of your hearing board a statement was presented on behalf of the Federal Water Pollution Control Administration and the Bureau of Sports Fishery and Wildlife Service, calling attention to the findings of last summer with ecological kill occurring above 92°F, and recommending to the Board essentially the same recommendations that were in the report presented this morning by Mr. Hagan -- in other words, 1½° above ambient temperature which your Board chose to ignore. Your Board also chose to ignore the fact that this Federal-State enforcement conference was imminent, because the decision was made by the Board subsequent to the announcement of this conference.

Paul W. Leach

MR. LEACH: Mr. Thoman, I completely disagree with you that the Board chose to completely ignore it. They took the matter in full consideration.

MR. THOMAN: Let the facts speak for themselves.

MR. LEACH: And they found that the statement was not necessarily in conflict with the evidence that was presented before the Board. This Board must make a decision based upon the evidence presented before it. It was a full open public hearing in which the Federal agencies were afforded the opportunity to present their arguments, as were the State agencies. It was considered fully, and all factors presented were taken into consideration on the decision which was made.

MR. STEIN: Are there any questions?

I want to thank you very much. By the way, I would like to see you and talk to you informally, because I think that we have a lot to talk over.

(Applause).

Now that we got that applause, let me tell you what you have done, Mr. Leach -- what you have done. If the industry has any difference with the State authorities or Federal authorities, as far as I can see -- and I don't blame them a bit -- the color of authority is going to be your approval without consulting and clearing and working together with your sister Federal agency and State agency. If you want to go home and live with that, you're welcome. I say this in absolutely no disrespect for the industry, because if I were working with them and I had their point of view, that's exactly what I would do. I think that they may have acted in an entirely reasonable manner.

MR. LEACH: Mr. Stein, I might point out that I have very little disagreement with you whatsoever on the positions that you have taken.

MR. STEIN: Thank you.

Mr. Reed.

MR. REED: Mr. Stein, I will ask the representative of Florida Power & Light to testify now. I believe Col. Davis will be in charge of the presentation, and will introduce whatever members he wishes.

MR. STEIN: On the question of time, do I understand that this will take about 2 hours?

COL. DAVIS: Yes, sir.

MR. STEIN: It's 4 o'clock. We'll give you all the time you want. If you're going to take 2 hours, in view of the time, I suggest that you go to 5:00, and then we will plan a 10 minute break and continue.

COL. DAVIS: That suits me.

COLONEL A. M. DAVIS, VICE PRESIDENT,
FLORIDA POWER & LIGHT COMPANY,
MIAMI, FLORIDA

COL. DAVIS: Mr. Chairman, conferees, ladies and gentlemen:

Mr. Stein, do you want my responsive statement?

MR. STEIN: Pardon?

COL. DAVIS: Do you want my responsive statement made to your statement a part of the record? I'm referring to your statement you made for Mr. Hickel. I believe that was before the record began.

MR. STEIN: No, no, that is part of the record, sir.

COL. DAVIS: Part of the record?

MR. STEIN: Yes, sir. Let me indicate it this way. I indicated that this was a special announcement that I was making as part of the record, before the opening statement. I intended to read that statement after the opening statement, and that is the way that you should consider it, in the record. But because the Assistant Secretary was here and wanted to hear it, he asked me to take this out of order and open with it.

So that is part of the record, sir.

COL. DAVIS: Fine.

I am A. M. Davis, Vice President of Florida Power & Light Company. I want to make a statement now in response to the surprising statement which Mr. Stein read before opening the conference this morning.

The statement that he read for Secretary Walter J. Hickel to the effect that the "Federal Government has communicated a number of times with officials of the Florida Power & Light Company regarding its proposed project" is incorrect.

On June 23, 1969, after 3½ years of studying Biscayne Bay, we called a meeting of all interested public officials, Federal, State and county (approximately 25 in number) and presented the results of our many studies and our proposed plan for a canal to Card Sound, which is exactly the same route as it is being constructed today.

Col. A. M. Davis

Until Mr. Stein read this statement this morning, we have never been requested by the Federal Government to refrain from implementing our plan, and we have never had any presentation by any of their representatives of any objections to the proposed canal. Thus, I say it comes as a surprise at this time.

After our June 23 meeting, we proceeded to condemn the property for the canal and the Circuit Court of Dade County entered an Order of Taking on October 5. We promptly thereafter commenced our plan for bidding and contracting the digging of the canal, and it was in the normal course of these procedures that the digging was commenced the first part of February.

Commencing last July, we have had hearings monthly before the Dade County Pollution Control Board. During that period we have also been in weekly communication with the Dade County Pollution Control Officer. After extensive, detailed, comprehensive review, he gave us a permit with restrictive measures in it. This was appealed to the Dade County Pollution Control Board, and after hearings they denied the appeal.

Col. A. M. Davis

As Mr. Stein stated in his jurisdictional statement, the primary jurisdiction in this matter is with the State. The State of Florida has certified the Dade County Pollution Control Officer as the State's representative in handling pollution matters, and we at all times since have followed his procedures.

Belatedly, about January 28, 1970, we received a letter from the State Water Pollution Control Board requesting that we get a permit from them in connection with our construction. In checking, the State did not have any rules or regulations filed and none effective, and they did not even have application forms which we could file. We advised them immediately that just as soon as they promulgated rules and regulations and had application forms we would forthwith file them.

Within the last few weeks, requests have been made to the Dade County Pollution Control Board, the Dade County Commission, the Circuit Court in Dade County, and the District Court of Appeals for the Third District of Florida, to require us to stop construction, and in each of these four instances such requests have been denied.

And the Federal Government did not have anyone to intervene.

We feel that we have conscientiously and in the highest integrity and good faith complied with all the rules, regulations and requirements in existence at all times of the governmental agencies at local, State and Federal levels in proceeding with this canal.

I'd like to digress a minute and talk about this permit system. I assisted in drafting the permit system for the State of Florida, which had a pollution control permit for construction. It also asked for an operating permit.

To date we have tried to get the forms, but to this date they are not available. Two days ago we asked Mr. Patton's office if there were any forms. "No." We said, "We will file them as soon as we get them." I may be wrong, but I don't think that the law is in effect today. The last time that we checked it --

MR. REED: Not according to the Secretary of State. That's correct.

COL DAVIS: I would like to say in behalf of Mr. Leach -- he was so bitterly attacked. He complied with whatever was there, and, by the way, I did check with the staff of the trustees of the Internal Improvement Fund.

While we are on permits, I might as well talk a little more.

MR. STEIN: Before you talk on permits, may I ask you a question?

COL. DAVIS: Yes, sir.

MR. STEIN: The question as I understand it, and I was directed to read, was whether or not you were going to make an announcement that you were going to stop the digging of that canal. I have heard no such announcement. Did you want to say yes or no?

COL. DAVIS: On that subject? No, sir, I cannot make -- there are many ramifications to that: the State, the County, the Directors of our company, and the requirements of the citizens who require elctricity in the State of Florida. And it is such an involved question that I am not going to answer it. I cannot answer it.

MR. STEIN: I understand your position fully, Col. Davis. As I understood the statement that I was asked to read this morning, this statement asked you for an affirmative statement that you were going to stop digging that canal. If that affirmative statement is not forthcoming, the way I understood it, the consequences are that the Secretary of the Interior would request the Justice Department; and I guess we will not get that statement.

COL. DAVIS: No, sir.

MR. STEIN: All right.

COL. DAVIS: Now, when we talk about permits on this, we had to start construction, and in order to insure against any of the fears that Mr. Thoman and possibly you expressed, our permit stops at least a mile from the shoreline. I did this in coordination with the staff of the Trustees of the Internal Improvement Board, and with the Department of Public Works in Dade County.

We had absolutely no intention -- I am well aware of the necessary permits that are required from the county, the Trustees of the Internal Improvement Board, and the Corps of Engineers. I am so well informed that I recall the instance of the present canal when Dade County, the Metro Commission approved it unanimously; the I. I. Board approved it unanimously. The Corps of Engineers said they were for it. Mr. Thoman told me, he said, "I know that it is illegal, but because of a departmental understanding I am asking the Corps of Engineers not to approve it."

We dug it as far as --

MR. THOMAN: Col. Davis, I said that it was illegal?

COL. DAVIS: You had no legal authority to do that, yes, sir.

MR. THOMAN: Let's get it in proper English. That I did something illegal?

MR. STEIN: I'm sorry. I'm sorry, panel, we will have to wait until Col. Davis finishes his statement.

Col. Davis, would you continue?

COL. DAVIS: We dug the canal as far as the Corps of Engineers told us we could, and the water went out. So, therefore, the FWPCA has to take some of the blame, if there is any, for the silt and part of the erosion, because we were not permitted to construct the canal on our own property which we have a deed for. We pay taxes on. We were not permitted to do it. As a result the transition of the canal is extremely abrupt, and there is some erosion, and it caused some silt to be deposited.

I just wanted to clear up this permit business.

MR. STEIN: Are you open for questions now?

COL. DAVIS: That's part of my presentation.

MR. STEIN: Let's see. Are there any questions or comments?

COL. DAVIS: I haven't finished.

MR. STEIN: All right. Let me know when you're finished.

COL. DAVIS: O. K. The question of thermal effects is one of extreme complexity, and it is by means of conferences such as this that these difficult problems may be thoroughly aired, and each concerned party may come to a fuller understanding of the matter.

I wish to place in the record at this time a document entitled "Chronology of Turkey Point Events" dated February 17, 1970. I'll not read this. Since June of 1963 there have been 97 significant events of conferences, permits, licenses, hearings and what-not, which are all necessary. Some are and some aren't in the development of a power system from the design to the operation, and we haven't got to the operation as yet.

N.R.Kincaid
2/10/70
Rev. 2/17/70

CHRONOLOGY of TURKEY POINT EVENTS

7 June 1963 - Acceptance of General Electric bid on turbines intended for expansion at Cutler Plant (turbines used at Turkey Point when Cutler expansion thwarted).

7 August 1963 - Applied for necessary zoning variances for the addition to existing Cutler Plant of two oil-fired units of 432,000 kw each.

9 September 1963 - Contract signed with Bechtel Corp. for expansion at Cutler Plant (contract transferred to Turkey Point when Cutler expansion thwarted).

31 March 1964 - Metro Commission ruled that expansion would be permitted only on condition that FPL use 100% gas in these units. Gas was not available in the quantity necessary. Consequently, FPL immediately sought another site in Dade County, a site which would be remote from population, be accessible to cooling water and the transportation necessary to supply fuel for the units. Turkey Point was about the last remaining section of waterfront in Dade County available for this expansion. Located 25 miles south of Miami, 5 miles from the nearest dwelling place, Turkey Point was an ideal spot for expansion of the necessary generating facilities. FPL purchased 1800 acres of land at Turkey Point and the site has subsequently been expanded to over 3500 acres.

26 May 1964 - FPL filed for an unusual use permit for the expansion of Turkey Point.

19 June 1964 - Permit granted by Dade County. Community leaders hailed the move by FPL as an unusual example of cooperation between industry and the community in selecting a site which would be free from interference of human habitation.

September 1964 - Began construction of Units 1 and 2.

15 November 1965 - FPL announced construction of two 760,000 kw nuclear units at Turkey Point to be Units 3 and 4, due to predictions of load growth continuing upward in Dade County. Our forecast told us that in the year 1970 our customers would use 2,360,000 kw, and in that year, even with the expansion of Turkey Point Units 1 and 2, the generating capability to handle that load in Dade County would only be 1,286,000 kw, about half of what would be needed. By 1975 the load in Dade County is expected to be 3,940,000 kw. It was obvious that still more generating facilities were needed to meet the inevitable expanding growth of Dade County and, consequently, plans and studies were undertaken.

November 1965 - Dames & Moore, Consulting Engineers in the Earth Sciences, retained to conduct geological and seismological studies at Turkey Point. Also - the University of Miami for meteorological studies.

26 March 1966 - Applied for Atomic Energy Commission permit.

March 1966 - Dr. W. S. Richardson, University of Miami, retained by FPL to study hydrology of Biscayne Bay, completes study and concludes Bay is well flushed.

15 December 1966 - Applied for re-zoning because of certain changes in the Metro Zoning Laws with respect to nuclear power plants.

27 January 1967 - Letter from Department of the Interior, Fish & Wildlife Service, to FPL, questioning Dr. Richardson's conclusions and expressing concern over possible deleterious effects of warm water discharge - the first communication received from a public agency suggesting possible harm.

FPL immediately began a wide search for information on the subject since no evidence existed that any of its plants in 40 years of operation had caused harm.

23 February 1967 - Re-zoning approved by Metro Commission.

22 April 1967 - Unit No. 1 went on the line.

29 April 1967 - AEC issued construction permits for Units 3 and 4 and construction began on nuclear units.

25 May 1967 - FPL letter to Mr. Paul Leach, Director, Dade County Pollution Control, advising him of the status of construction at Turkey Point and our desire to cooperate in carrying out the Dade County Pollution Control Ordinance including the application for variance, if necessary. He was invited to visit Turkey Point to inspect the canal system and discuss the subject.

26 May 1967 - Letter from Mr. Paul Leach, Director, Dade County Pollution Control, to FPL, acknowledging our willingness to obtain any variances and removing any of his objections to the Dade County Building and Zoning Department's issuance of necessary construction permits.

May 1967 - Mr. Richard O. Eaton, Consulting Coastal Engineer, Dr. James H. Carpenter and Dr. Donald W. Pritchard of the Chesapeake Bay Institute of Johns Hopkins University, retained to conduct studies of mixing characteristics of Biscayne Bay.

1 November 1967 - FPL letter to Florida State Board of Health requesting an exception to exceed State temperature limit of 93°F after reasonable mixing for a small percentage of time. Also, FPL commitment to take corrective action if there is any scientific proof that there is degradation of the waters by increased temperatures after reasonable mixing.

7 November 1967 - Temporary exception granted FPL by Florida Air & Water Pollution Control Commission, provided FPL initiate studies to establish "background" data on water quality and existing condition of the marine biology and ecology of the area. (Exception granted pending completion of study, at which time matter would be reevaluated.)

24 November 1967 - Letter from Mr. Lloyd E. Miller, President, Mangrove Chapter, The Izaak Walton League of America, to the Florida Board of Health (copy to FPL) wherein he advocates:

1) That a means be developed that would force the Turkey Point cooling water to take a long cooling path before being discharged into the Bay.

2) That FPL dig an additional 8,000 feet of 100 foot-wide cooling canals.

In effect, Mr. Miller suggested, essentially, the method FPL subsequently selected to handle the cooling water.

7 December 1967 - Letter from Mr. Randolph Hodges, Director, Florida Board of Conservation, to Mr. McGregor Smith, Chairman of the Board, Florida Power & Light Company, stating that the State Biological Report of the area off the present main Turkey Point discharge canal and within the bulkhead line had some red algae (seaweed) but no attached sea grasses. Further, that there was no sport or commercial fishing in the area. (Letter was in connection with FPL application for permit to dredge offshore channel outlet in conjunction with upland dredging and construction of main discharge canal.)

10 January 1968 - Bechtel Corp. retained by FPL to conduct study on methods of cooling the discharge waters at Turkey Point.

25 January 1968 - Dr. James B. Lackey, Microbiologist, Professor Emeritus, University of Florida; Dr. Charles B. Wurtz, Biologist, LaSalle College; and Dr. Joseph S. Davis, Marine Botanist, University of Florida; retained to conduct periodic tests of the plankton, grasses, algae and invertibrates in the Bay. Also - Mr. Roger Yorton, Chemist, University of Florida, to conduct periodic chemical analyses of the waters.

January 1968 - FPL active in assisting Institute of Marine Sciences, University of Miami, in obtaining grants from AEC and Department of the Interior to conduct ecological studies.

1 February 1968 - FPL funds two-year graduate research project at University of Miami, Institute of Marine Sciences, to investigate fish and larger marine animals at Turkey Point.

25 April 1968 - Unit No. 2 went on the line.

5 May 1968 - Mr. Richard O. Eaton, Consulting Coastal Engineer, Dr. James H. Carpenter and Dr. Donald W. Pritchard of the Chesapeake Bay Institute of Johns Hopkins University, retained by FPL to conduct studies of mixing characteristics of Biscayne Bay, conclude a strong possibility of recirculation when nuclear units put on line in 1971 and 1972. This would possibly have cumulative effect on temperature rise of water.

29 August 1968 - Letter from Mr. Paul Leach, Director, Dade County Pollution Control, directing FPL to make known within 15 days the steps planned to correct violation of the Dade County Code and a time table for the actions. Also - that FPL could alternately apply for a variance before the Pollution Control Board.

10 September 1968 - Discussion with Dames & Moore concerning the feasibility of developing a source of coolant water from deep wells.

24 September 1968 - FPL contracts with Department of Coastal and Oceanographic Engineering, University of Florida, to study hydrological effects of several alternative schemes of intake and discharge canal arrangements and dilution methods designed to eliminate recirculation and excess temperature. Dr. Robert G. Dean to supervise study.

27 September 1968 - FPL letter to Mr. Paul Leach, Director, Dade County Pollution Control, advising that if a variance was required in his judgment to treat the letter as an application for variance.

11 October 1968 - Mr. A. M. Davis and Mr. D. W. Matson of FPL visited Mr. Paul Leach, Director, Dade County Pollution Control, to determine the requirements for a variance for the Turkey Point Plant and Cutler Plant.

14 October 1968 - Meeting in Atlanta between Mr. J. R. Thoman, Regional Director, Southeast Region, Federal Water Pollution Control Administration, and Mr. Nathaniel Reed, then Special Assistant to the Governor of Florida, and Mr. McGregor Smith and Mr. A. M. Davis of FPL, regarding the possibility of handling the cooling water at Turkey Point by means of a canal with dilution discharging into Card Sound. FPL explained that investigation of this method entailed a year long study of hydrological effects which FPL was prepared to have accomplished by the University of Florida. Both Mr. Reed and Mr. Thoman indicated that it may be a good solution.

18 October 1968 - Public Law 90-606 (90th Congress, H.R. 551) enacted authorizing the establishment of the Biscayne National Monument in the State of Florida, and for other purposes.

7 November 1968 - Temporary variance request by FPL before Dade County Pollution Control Hearing Board until July 1969, at which time FPL to reopen before Board with plan to reduce temperature of water to an acceptable level. Board was given complete details on the extensive engineering, hydrological, hydrographic and ecological studies under way. Board adjourned - no decision on variance.

17 November 1968 - Conference at Turkey Point attended by biologists from FPL, University of Miami, University of Florida, Florida Board of Conservation, Florida State Board of Health and Federal Water Pollution Control Administration. At this meeting, FPL presented the details of its biological research program and requested suggestions and comments from the assembled scientific group. Several suggestions were made and incorporated into the program.

5-7 December 1968 - President's Water Pollution Control Advisory Board hearing in Miami and visit to Turkey Point where Mr. Nathaniel Reed, then Special Assistant to Governor Kirk, said that cooling towers were out and advocated an extended canal system as a solution to the cooling water problem at Turkey Point. On several other occasions, Mr. Reed stated that we needed an extended canal system.

19 December 1968 - Hearing by Metropolitan Dade County Pollution Control Hearing Board on FPL temporary variance request. Board adjourned - no decision on variance.

9 January 1969 - Hearing by Metropolitan Dade County Pollution Control Hearing Board on FPL temporary variance request. Board adjourned - no decision on request.

20 February 1969 - FPL contract with Institute of Marine Sciences, University of Miami, to conduct Survey Study of the Biota of Card Sound.

20 February 1969 - Temporary variance granted FPL by Metropolitan Dade County Pollution Control Hearing Board until 31 July 1969, at which time FPL to submit plan for reducing water temperature and schedule of construction.

1 April 1969 - Variance upheld by Metropolitan Dade County Commission on appeal.

30 April 1969 - Retained Mr. Robert T. Spearman, Little Fin, Inc., Riviera Beach, to conduct underwater photography survey at Turkey Point.

14 May 1969 - New 5-member, all professional, Metropolitan Dade County Pollution Control Hearing Board, appointed by Metropolitan Dade County Commission, after abolishment of previous Board.

13 June 1969 - Dames & Moore retained to further study hydrology of proposed 5 mile canal - to support their preliminary belief that canal posed no hydrological implications.

23 June 1969 - FPL held conference and presented plan for cooling water selected after exhaustive studies which were explained in detail. Conference included representatives from all County, State and Federal agencies. Concurrence in the plan and/or suggestions as to a better plan were solicited from all.

27 June 1969 - FPL filed petition in Circuit Court for condemnation of Seadade property required for cooling water canal to Card Sound.

30 June 1969 - A written statement of the presentation was forwarded to all conferees, as well as the Office of the Governor of the State of Florida, the AEC, the Dade County Manager, and the Regional Coordinator of the U. S. Department of the Interior, Atlanta. Concurrence in the plan was requested. To date only two agencies have responded - the Corps of Engineers and the Central and Southern Florida Flood Control District, both of whom concurred in the plan.

29 July 1969 - FPL presented plan to new Metropolitan Dade County Pollution Control Hearing Board along with construction schedule and request for extension of the temporary variance until July 1971 - time required to complete construction. Board recessed with no decision except to extend variance until 1 October 1969.

30 July 1969 - Depositions for Seadade condemnation suit - Mr. Robert Gardner and Mr. Theodore Slack.

5 August 1969 - FPL contracts with Brown & Root to conduct cooling water study for Turkey Point Power Plant. Also, separate contract with Rader & Associates, Miami, to study problem of handling the cooling water at Turkey Point.

5 August 1969 - FPL contracts with Dames & Moore, Consulting Engineers in Applied Earth Sciences, Atlanta, for Cooling Water Study for Turkey Point Power Plant.

6 August 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

6 August 1969 - FPL request for proposal from Dames & Moore to study feasibility of construction and hydrologic influence of impounding ponds to cool discharge water.

14 August 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

15 August 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

15 August 1969 - Deposition for Seadade Condemnation Suit - Miami - Mr. Robert O'Hara.

18 August 1969 - FPL contracts with Florida Ocean Sciences Institute to conduct underwater photobiological survey in Card Sound in the vicinity of the Model Land Company Canal.

19 August 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

20 August 1969 - Deposition for Seadade Condemnation Suit - New York - Mr. Loren Crow.

21 August 1969 - Depositions for Seadade Condemnation Suit - New York - Mr. Herbert C. Gee and Dr. Charles L. Hosler.

August 1969 - Following consultants retained to study meteorological effects of canal: Dr. Mariano Estoque, Professor of Meteorology, University of Miami; Dr. John B. Koogler and Admiral Anthony Danis (U.S. Navy Ret.) of Environmental Engineering Inc.; Dr. Gordon E. Dunn, former Director, National Hurricane Center (1955-68).

2 September 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

18 September 1969 - Metropolitan Dade County Pollution Control Hearing Board resumed hearing. Expert witnesses in the area of hydrology, hydrographic engineering and ecology testified in behalf of the plan. Massive evidence was presented to the Board. Board adjourned with no decision except to extend temporary variance until 3 October 1969.

22 September 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

29 September 1969 - Hearing before Judge Vann, Circuit Court - Seadade Condemnation Suit.

2 October 1969 - Metropolitan Dade County Pollution Control Hearing Board continued hearing which was to be confined solely to deliberation by the Board and the possible taking of notes. Meeting was adjourned with no decision except to extend variance until 14 November 1969 and order additional information on the feasibility of an ocean outfall method of discharging the cooling water to be presented at next meeting.

8 October 1969 - Order of Taking for Seadade property granted FPL by Circuit Court after some four months since initiation of condemnation action in June involving drawn out court proceedings.

9 October 1969 - FPL retains Bechtel Corp. and Rader & Associates to conduct further independent studies of the cost and engineering of an ocean outfall method for handling the cooling water at Turkey Point - in response to Pollution Board request for more detail on method.

30 October 1969 - The County Attorney, for Dade County, renders opinion that the Metropolitan Dade County Pollution Control Hearing Board had no authority to grant approval of the FPL cooling water plan - this was a function of the Dade County Pollution Control Officer. Also, that the sole matter over which the Board had jurisdiction at the time was the amount of time FPL was to have in order to comply with the County Code. This meant that all the time, effort and expense suffered by FPL in presenting its plan to the Board was down the drain!

7 November 1969 - Order of Taking appealed by Seadade to District Court.

13 November 1969 - Metropolitan Dade County Pollution Control Hearing Board hearing resumed. FPL presented additional detailed information on the feasibility of an ocean outfall via expert witnesses.

Decision of Board was -

"Conclusion - This Board concludes that it is in the best interest of the public for Florida Power & Light Company to submit a workable plan to eliminate the thermal pollution at the Turkey Point Plant through the Pollution Control Director prior to February 1, 1970.

"It further concludes that it is in the public interest for Florida Power & Light Company to enter into an agreement for the construction of whatever system is approved by the Pollution Control Director pursuant to its workable plan prior to 1 April 1970, and that said agreement must provide for completion of said system prior to 1 July 1971.

"It is therefore ordered that Florida Power & Light Company is hereby granted an extension of time within which to comply with the thermal pollution provision of the Dade County Code up to and including July 1, 1971, the following conditions being attached thereto:

"That this extension shall cease as of February 1, 1970, if prior to that date Florida Power & Light Company has not received approval by the Pollution Control Director of a workable plan for the elimination of thermal pollution at the Turkey Point Plant; that this extension shall cease as of April 1, 1970, if prior to that time Florida Power & Light Company has not entered into an agreement for the construction of whatever facilities are approved by the Pollution Control Director for the elimination of thermal pollution at the Turkey Point Plant, and if said contract does not provide for completion prior to July 1, 1971."

14 November 1969 - Bids received on construction of Southern Reach portion of cooling canal to Card Sound.

18 November 1969 - FPL plan submitted to Director, Dade County Pollution Control, via application for Pollution Control Permit with offer to fund an ecological monitoring plan mutually acceptable to his office, the State of Florida and FPL.

5 December 1969 - Plan approved by Director, Dade County Pollution Control, with following stringent conditions:

"1. The five (5) axial flow pumps specified shall be so designed to have a capacity of approximately 840 cubic feet per second, instead of 785 cubic feet per second as specified at 3.6 feet T.D.H.

"2. There shall be supplied one additional pump over the five proposed which shall be in a place and ready for operation so that regular maintenance may be accomplished on those in service without any loss in pumping capacity.

"3. An additional three (3) pumps shall be supplied within six (6) months, upon notice by this office that such are needed to increase the dilution capacity by an additional fifty per cent (50%).

"4. The Florida Power & Light Company shall submit a plan for a system of water temperature monitors to the Pollution Control Department to provide a satisfactory monitoring system which will provide the department with continuous information concerning ambient conditions in the total cooling water system.

"5. The Florida Power & Light Company shall fund the necessary ecological and hydrological studies of lower Biscayne Bay and Card Sound commencing April 1, 1970, and continuing for at least one (1) year after all units of the facility are in operation. These studies, prior to initiation, shall be agreed upon by the U. S. Department of the Interior - Federal Water Pollution Control Administration, State of Florida Department of Air and Water Pollution Control, Dade County Pollution Control Department and the Florida Power & Light Company."

8 December 1969 - Construction Permit issued by Metropolitan Dade County Public Works Department for Southern Reach of Canal from our existing canal system to North Line of Section 28-58-40. (This does not cover entire system.)

8 December 1969 - Mr. Nathaniel Reed, Chairman, Florida Department of Air & Water Pollution Control, called FPL with message from Governor Kirk to the effect that Governor Kirk had requested U. S. Secretary of the Interior Hickel to hold Federal-State Conference concerning Turkey Point Plant, in accordance with Federal Pollution Control Act.

10 December 1969 (approximate) - Announcement that Federal-State Conference on Turkey Point to be held in Miami on 24 February 1970.

11 December 1969 - Letter of Intent issued B. B. McCormick & Sons of Jacksonville to award them contract for constructing portion of canal authorized under Dade County Construction Permit - $3.5 million.

18 December 1969 - FPL application for Class 1 Dredging Permit to Dade County Public Works Dept. for intake and discharge dredging for Cooling H_2O System in Biscayne Bay and Card Sound.

19 December 1969 - Pollution Control Permit appealed to Metropolitan Dade County Pollution Control Hearing Board by Seadade and the Izaak Walton League.

9 January 1970 - Petition by Izaak Walton League to Florida Air & Water Pollution Control Commission to issue order prohibiting construction of FPL cooling water system unless Chapter 403 of the Florida Statutes is complied with.

14 January 1970 - Metropolitan Dade County Pollution Control Hearing Board hearing to act on appeal of Pollution Permit plus request to stay FPL construction. Board adjourned after listening to four hours of testimony by Seadade and the Izaak Walton League with no decision. FPL agreed not to start construction until 1 February 1970.

19 January 1970 - Retained Dr. Gordon Gunter, Biologist, and Director of Gulf Coast Research Laboratory - to augment ecological study efforts.

27 January 1970 - Mr. V. D. Patton, Executive Director, Florida Department of Air and Water Pollution Control, letter to FPL advising of new State Pollution Permit system to go into effect next 30 days which will require construction permit from his department for pollution control equipment.

28 January 1970 - Dade County Commission denies Izaak Walton League request to stay FPL construction of cooling system canal authorized by construction permit issued by Dade County Public Works Department.

29 January 1970 - Metropolitan Dade County Pollution Control Hearing Board hearing resumed on appeal of FPL pollution permit. No decision after 3½ hours of testimony on permit or stay of construction. Next meeting set for 12 February 1970. FPL told Board it planned to proceed with construction 1 February 1970.

30 January 1970 - Contractor notified to proceed with actual dredging by 1 February.

30 January 1970 - Letter to Florida Department of Air and Water Pollution Control from Izaak Walton League asking State to halt canal construction.

30 January 1970 - FPL letter to Mr. V. D. Patton, Executive Director, Florida Department of Air and Water Pollution Control, in response to his 27 January 1970 letter - (1) FPL would promptly file for State Pollution Permit when new system became effective; (2) meanwhile, FPL had followed all Dade County procedures (approved by the State)

in obtaining a Dade County Pollution Control Permit; and (3) that the 1 February 1970 construction starting date was dictated by the actual completion date of March or April 1971, mandatory to supplying the public power requirements of June 1971.

3 February 1970 - Seadade motion before Circuit Court to stay FPL cooling water system construction denied on grounds jurisdiction rested with District Court.

4 February 1970 - Proposal requested from engineering firms to study ponds as a supplement to canal with dilution. Also - to study use of deep wells as supplemental cooling to canal with dilution.

4 February 1970 - Mr. McGregor Smith's letter to Governor Kirk requesting that he do nothing to delay the coming in of the nuclear generating unit at Turkey Point before giving FPL an opportunity to talk to him. Also - information on the electrical power demands facing the Company, our actions and the impact of further delays. Further - our concern over Federal intervention.

9 February 1970 - Hearing before District Court of Appeals on Seadade appeal of the Order of Taking granted by the Circuit Court and on Seadade's motion to stay FPL construction at Turkey Point. Court denied motion to stay construction and has affirmed the taking except it has directed that additional evidence be taken as to the length and type of title necessary for FPL to accomplish its purposes for the storage of muck and rock material.

12 February 1970 - Metropolitan Dade County Pollution Control Hearing Board resumes hearing on appeal of pollution permit and stay of construction. Hearing recessed until 19 February 1970. Testimony closed.

Col. A. M. Davis

COL. DAVIS: The story of Turkey Point really begins with our proposal to expand the 80-acre Cutler Station, located 10 miles south of Miami, by the addition of two 432 megawatt units. The people of Dade County told us to locate these plants elsewhere because a residential area had developed around Cutler Station.

Consequently, in the spring of 1964, we bought 1800 acres of land 25 miles south of Miami on the edge of Biscayne Bay, which was five miles from the nearest house, and later we acquired an additional 1700 acres. In September of 1964, construction on the two units started. This move was hailed as an example of industrial statesmanship.

A Miami Herald editorial of May 26, 1964 said:

"Metro Commission ought to encourage Florida Power & Light Company in its proposed plant expansion at Turkey Point. The location is far from Cutler, which has become a prime residential area, and is remote from any habitation."

We should mention at this time that our Cutler Plant had been operating on Biscayne Bay since 1948, utilizing Bay water for condenser cooling without the first public concern being expressed about the effects of heated water, excluding the complaints of fishermen who found the banks too crowded with other fishermen.

In the fall of 1965, we announced plans for two nuclear units at Turkey Point, and immediately thereafter, the necessary environmental studies commenced. Among these was a study of the mixing and flushing characteristics of Biscayne Bay. The results of this study indicated that Biscayne Bay was well flushed.

AEC licensing proceedings were carried out throughout the year 1966, and in January 1967, the AEC staff completed its work and issued its safety analysis report. As is customary, our license application was examined by the U. S. Fish and Wildlife Service and their letter of comment to the AEC was appended to the AEC report.

Our receipt of this report in February of 1967 was the first indication on the part of any public agency of concern for adverse thermal effects from the plant. At this time, the design and construction of the plant had been under way for 3 years.

Shortly thereafter we retained Mr. Richard O. Eaton and Drs. Pritchard and Carpenter of Johns Hopkins

Col. A. M. Davis

University to restudy the mixing and flushing characteristics of the Bay. In April of 1967, Unit No. 1 went into operation for the first time.

In January of 1968, Bechtel Corporation, the engineer-constructor of our Turkey Point Plant, was directed to conduct an engineering study of all available cooling water methods and recommend an augmented cooling water system. This system was to meet the Dade County criteria of 95° and the State criteria, which at this time was a maximum of 93°F after reasonable mixing, except that when the ambient exceeds 88°, and increase of 5° over ambient was allowable. That at one time was the State code.

At the same time, we began biological studies since intensive study had disclosed relatively little knowledge of Biscayne Bay ecology. Field studies on mixing were conducted in the spring of 1968.

In the summer of 1968, we received the report of Bechtel, and the report of Pritchard and Carpenter.

The pritchard-Carpenter report disclosed the existence of 20 percent recirculation and predicted 70 percent recirculation with the operation of all four units.

Col. A. M. Davis

The Bechtel Report disclosed the existence of disadvantages with each of the methods considered; namely, ponds, cooling towers, and dilution, and combinations thereof. Bechtel had been unable to consider recirculation in their work because of the absence of field work; consequently, they were asked to continue study in light of the Pritchard-Carpenter report, and to consider additional alternatives, such as the ocean outfall. Dames & Moore, well known earth scientists, brought to our attention a consideration of deep well disposal.

In the meantime, on the regulatory front, the Department of the Interior had not approved the Florida temperature standard and protracted discussions on the matter were taking place. Consequently, we had only the Dade County standard to work with.

The Dade County Pollution Control Officer, Mr. Paul Leach, cited the Company for Ordinance violations during the summer of 1968, and on October 11 we requested a variance until July 1969, to come in with a feasible method to cool the water.

Within 7 days of that date the Islandia National Monument Act was passed.

At this point -- can you see this chart here, Mr. Stein? This is a chart of the United States Coast and Geodetic map.

MR. STEIN: Why don't you bring it up closer?

COL. DAVIS: This is a map of Biscayne Bay, and it includes the boundaries of Islandia National Monument. It also shows the proposed discharge into Card Sound. This is an easement for the channel, and in this area it is a proposed area for -- the Act states that the Secretary cannot extend those boundaries to the south.

At this point Florida Power & Light was faced with several significant considerations.

1. There was one temperature standard in existence: 95°.

2. Recirculation with its cumulative temperature buildup and consequent increased potential for damage, must be eliminated.

3. The discharge should be removed from Islandia National Moument.

A canal to Card Sound will get the discharge out of Islandia and will eliminate recirculation. Eliminating recirculation meant that it was feasible to utilize dilution as a means of cooling the water and thereby conform with the one existing temperature limit.

We say this with emphasis because it has been said that all we wanted to do was transfer the problem to another body of water. Such a statement could not be further from the truth. Our prime motivation was to avoid recirculation so that the water would be cooled to acceptable limits. Beneficially, it would also eliminate any adverse effects on Islandia.

Consequently, we did two things. First, we retained the University of Florida to study the Card Sound Canal and dilution plan and determine the temperature fields and possible recirculation.

Secondly, Mr. McGregor Smith and I met in Atlanta on October 14, 1968, with Mr. John Thoman of the Federal Water Pollution Control Administration, and Mr. Nat Reed of the Florida Air and Water Pollution Control Commission. We told them of our belief in the canal-dilution system and asked them for their reaction. We were told that our idea appeared to be a satisfactory solution to the problem. To date that plan has not changed.

During October, 1968, the Honorable Claude M. Kirk, Governor of Florida, volunteered to assist Florida Power & Light Company in obtaining the property required for the canal to Card Sound.

Col. A. M. Davis

On December 6, 1968, the President's Water Pollution Control Advisory Board of the President of the United States visited Turkey Point. A presentation was made in which an extended canal and dilution system was explained.

At this time Mr. Nat Reed stated that cooling towers were unacceptable because of the rich farming area, and that probably an extended canal system was the best solution.

In May of 1969, the work of the University of Florida was completed and the results were favorable. Consequently, on June 23, 1969, we called a meeting to discuss the canal-dilution plan with every interested public agency -- County, State, Federal and educational institutions.

There were 38 conferees representing 14 agencies, including those from the Federal Water Pollution Control Commission, National Park Service -- Mr. Raftery attended -- Fish and Wildlife Service, Florida Board of Conservation, and Florida Game and Freshwater Fish Commission.

We made a full disclosure of the plan, utilizing several charts and diagrams. We explained the advantages of the plan and gave our reasons for rejecting other cooling methods. We requested comments and suggestions. There was only one idea given, and that came from a group for outdoor recreation who suggested that we snake and twist canals for many, many miles through Seadade's property to cool it down and make it more aesthetically acceptable. I don't think that Seadade would have accepted that.

On June 30, 1969, we sent a letter to each one of the participants, enclosing copies of all the material presented on June 23. Again we requested their concurrence and assistance, emphasizing the urgency of their approvals in order that the project could be completed by the summer of 1971.

To date, eight months and one day later, the only replies received were from Dade County who asked for additional information. No reply has as yet been received from any agency attending the conference except Dade County, the Central and Southern Florida Flood Control District, and the Corps of Engineers.

The Central and Southern Florida Flood Control District and the Corps of Engineers concurred that our plans would be compatible with drainage and flood control systems in this area. Dade County asked for additional information which we furnished. We never did receive any written reply, and the only thing that I can recall that this was ever brought up, one time there was a presentation made up in Tallahassee. I just happened to be there and asked could I have a copy, and I noticed there were a good many charts that looked familiar, and some other things, but Mr. Reed, Mr. Patton never replied to our letters.

On July 29 the plan was presented to the Dade County Pollution Board. On October 8 an Order of Taking was entered in the Circuit Court for the necessary property.

On November 13 the Dade County Pollution Control Board granted an extension of time to July 1, 1971, to obtain approval of the canal-dilution plan and have it constructed.

On December 5 the Dade County Pollution Control Office approved the plan with stringent conditions for the protection of the environment.

On December 8, Dade County issued a construction permit. The Dade County Pollution Control Board -- and if you notice, Mr. Stein, that was long before the hearing was held on the Florida system. The

Dade County Pollution Control Board, the Dade County Commission, the Circuit Court, and the District Court of Appeals have rejected a request to stay the canal construction.

On February 19, 1970, the Florida District Court of Appeals upheld the taking for the canal property.

On February 19, 1970, the Dade County Pollution Control Hearing Board upheld the decision of the Dade County Pollution Control officer. I would like to remind everyone that this board is comprised of five highly qualified persons, including three PhD's in the biological sciences, and two professional engineers. It is interesting to note that members of this board posses those qualifications as recommended by conservation groups in Dade County.

In summary, what does the Turkey Point story say?

It says that Florida Power & Light has spent over a million dollars in research and study on this vital problem. We have utilized dozens of experts, hundreds of pages of reports, thousands of pages of transcript.

Col. A. M. Davis

We have cooperated with every interested public agency. All our research has been made available to them. We have sought their advice. We have considered the views of concerned members of the public.

For example, on Sunday, October 17, 1968, we held a seminar at Turkey Point on the subject of our biological study program. This seminar was attended by Mr. Purkerson of the Federal Water Pollution Control Administration, Mr. Woodburn and Mr. Routa of the Florida State Board of Conservation, as well as several University of Miami biologists.

We asked for comments and suggestions on the adequacy of our program and received only one -- this from Dr. DeSylva which we put into effect.

We have participated in conferences, seminars, courses and hearings all over the country in our search for insight into the problem.

At Turkey Point our concern for enhancing the environment has caused us to set aside 3000 acres of our buffer zone as a wildlife preserve, and have developed Scout Camps and recreation areas where our young people and the public can observe an unspoiled wilderness area firsthand.

Col. A. M. Davis

As South Florida's urban area rapidly expands, Turkey Point may well be the last wilderness area left on Biscayne Bay. There is only one, Homestead Park, at this time.

We have considered every possible alternate system for cooling, and as we shall describe, each alternate has serious environmental consequences potentially as adverse as that which we seek to correct. We cannot, in the exercise of our responsibility to the public, adopt unproven, untried and potentially harmful systems.

Finally, throughout 6 years of design and construction, there has been and still is only one numerical standard to which we could design our system: Dade County's 95°. The other non-numerical standard which we have is a "no damage" standard. It is clear that despite intensive study and research during this same 6 year period, there is still inadequate knowledge to conclude that damage occurs at 95°, much less that such alleged damage is irreversible. This standard of 95° was recommended by a highly qualified board including a scientist from the Institute of Marine Sciences.

Col. A. M. Davis

On Page 4 of application to the AEC for a grant to study thermal effects in Biscayne Bay, the Institute of Marine Sciences of the University of Miami said:

"At the present time we know virtually nothing of the biology, chemistry, or hydrography of the south bay marine environment."

And on Page 7 said:

"Each estuary is inevitably different from previous sites of study."

The proposal was sponsored by Drs. Voss and Idyll. Although this proposal was not accepted; subsequently the AEC and the Federal Water Pollution Control Administration awarded a grant for a similar proposal of lesser extent to Dr. Richard Badner of the Institute of Marine Sciences.

Shortly thereafter, The Miami Herald on August 21, 1968 commented:

"At last scientific know-how is getting a chance to substitute facts for emotions in a local controversy ... Prerequisite to answering that question (whether heated water will or won't hurt fishing or other natural values thereabouts) is knowledge of interrelations between animals, plants, air, water and so on in the bay."

The University of Miami study has been under way for 18 months and has not concluded that harm occurs to the aquatic life at 95°.

Secretary of the Interior Walter J. Hickel, in an interview with U. S. News & World Report, published November 10, 1969, said:

"The term 'thermal pollution' is misleading ... they have been led to believe that any time you raise the temperature of a body of water 5 degrees you are polluting it. That's ridiculous ..."

So much for the past. Where do we stand today?

Throughout the entire period of design and construction there has been only one numerical temperature standard in existence: Dade County's 95°.

Research at the University of Miami, funded by the Federal Water Pollution Control Administration, has indicated damage at the outlet of the present canal. The scientists conducting this study have testified in public that the research has not progressed to the point that the cause of damage can be positively identified as excess temperature, nor are the scientists able to say at what temperature damage will occur.

It was my understanding that this study by Dr. Roessler and Mr. Zieman was funded by the FWPCA, but not an FWPCA study as such. I was told that in Mobile.

The canal-dilution system is the one proven system which can be in operation by the time the first nuclear unit is on the line. All of the other possible cooling methods have serious, adverse environmental effects or unknowns which cannot be resolved in time for us to meet the electric demand in the summer of 1971.

Faced with this knowledge, we have designed and are constructing a system which has the following features:

1. It removes the discharge from the proposed Islandia National Monument.

2. It limits the maximum discharge temperature to 95°. This is an important point. This 95° will lower the temperature from 10 to 12°. I don't think that any scientists that have appeared

here have really evaluated what will happen when you reduce it by 10 to 12. They have their conclusion of what's out there, but I don't think that it has been evaluated. If it has, I haven't seen it. That's an important point.

3. It eliminates recirculation with consequent temperature buildup.

4. It removes discharges from a shallow area to a 9-10 ft. deep basin.

5. It removes discharges from a highly productive area to a less productive area. This is verified by a report dated July 1969, from the University of Miami Institute of Marine Sciences.

6. It removes the discharge to an area proposed for a heavy seaport, access to which is obtained by means of a deep water channel on an easement specifically reserved in the Act of Congress creating Islandia National Monument.

7. The plan has been accepted by the Dade County Pollution Control Officer with several conditions, all of which we have accepted, and an extension of time has been granted by the Dade County Pollution Control Hearing Board until 1971 for the construction of the system.

Col. A. M. Davis

8. An ecological hydrological and meteorological study which is acceptable to Dade County, the State of Florida and the Federal Government, will be funded by Florida Power & Light as one of the conditions of the Dade County Pollution Control officer. This study will be in operation for 1 year prior to the canal's operation, creating a real natural laboratory to really obtain the facts.

9. A temperature monitoring system will be installed by Florida Power & Light at their expense which will provide continuous temperature information to the Dade County Pollution Control Office.

10. An engineering research and development program directed toward resolving existing problems with alternate cooling systems will be conducted at our expense.

11. Should the results of the environmental research program that I described demonstrate that further temperature reduction is necessary, we will immediately proceed with steps to accomplish the necessary reduction.

12. I wish to reemphasize the point that the dilution system will reduce the temperature of the discharge water by 10 to 12° below what is presently

discharged. This really renders the Federal Water Pollution Control Administration report irrelevant.

In summary, the proposed system eliminates the need of the people of Florida who we serve with electricity to choose between the environment and an adequate supply of electricity. It eliminates that need. They'll have both.

The canal-dilution system will be in operation in the time allowed by Dade County and in time to meet the electric needs of the people in the summer of 1971. It will not cause harm to the environment to the best of our knowledge. It provides safeguards against any possible future harmful effects.

I have a short statement by our attorney.

MR. STEIN: Do you want to answer questions now? Do you want to hold yourself open for questions now?

COL. DAVIS: Well, Mr. Stein, if I can complete, maybe it will answer some, or maybe it will be a duplication.

MR. STEIN: You suit yourself. The problem here is the preservation of the record. Usually it is desirable not to go too far ahead. How much further do you want to go ahead?

COL. DAVIS: I imagine that I'll take about 5 or 10 minutes.

MR. STEIN: Go right ahead.

COL. DAVIS: I have a statement from our attorney that I'd like for him to make at this time. Mr. William Steel.

WILLIAM C. STEEL, ATTORNEY AT LAW,
FLORIDA POWER & LIGHT COMPANY,
MIAMI, FLORIDA

MR. STEEL: My name is William Steel, and I am a lawyer for Florida Power & Light Company, and I want to read into the record and make a motion at this time. This is a motion of Florida Power & Light Company to strike the Report of Thermal Pollution of Intrastate Waters in Biscayne Bay, Florida, on the grounds that the report and the recommendations thereof are based on gross factual inaccuracies, and, therefore, do not constitute competent evidence, and are not of any probative value in these statutory proceedings, all on the following grounds, and for the following reasons:

1. The Report fallaciously assumes that the measure taken toward abatement of the alleged thermal

pollution would utilize only 100 percent dilution of the cooling water before discharge into Card Sound. Whereas, in fact, the plan approved by the Dade County Pollution Control officer, and affirmed on appeal by Dade County Pollution Control Board, provides for 150 percent dilution; and

2. The report assumes and illegally prejudges that Florida Power & Light Company will violate the law; to-wit; in assuming and concluding that it would discharge waters into Card Sound at a temperature in excess of 95°, even though under the permit which it has been granted by the Dade County Pollution Control officer, it is prohibited from discharging such waters in excess of 95°, and this assumption and conclusion is illegal and injudicious and utterly unwarranted.

3. Neither this conference nor the Secretary of the Interior can perform and fulfill their statutory duties and functions under Title 33, United States Code, Section 466 g (d) (4) (B), by considering or utilizing the report or its recommendations in determining under said statutory subsection the adequacy of measures taken toward abatement of the

pollution, because such report and conclusions and recommendations based thereon are based on the gross inaccuracies stated above.

Wherefore, Florida Power & Light Company moves to strike said report from the record herein.

MR. STEIN: Mr. Steel, as I pointed out at the beginning, under the law, for the State of Florida and the Department of the Interior, we only entertain motions from parties to this conference. The other people are invitees and participants. Therefore, we can't entertain the motion.

However, I would strongly urge that the conferees take into consideration substantive points that you made in that resolution in evaluating the Federal Pollution Report.

MR. STEEL: In view of that, I believe, Col. Davis has some further statements to make in connection with that report.

MR. STEIN: Mr. Steel, do you have any extra copies of that statement, or can you get them?

MR. STEEL: Yes, we do.

MR. STEIN: Thank you. We'd appreciate it. Col. Davis.

Col. A. M. Davis

COL. DAVIS: This report is totally irrelevant regarding the situation that now exists at Turkey Point Powerplant. The proposed system for discharging of plant cooling water into Card Sound will result in temperatures dramatically below the temperature -- three times of that which now exists at Turkey Point and on which this study is based.

The maximum temperature that this water will be discharged in Card Sound is 95°. The area in which this study claims damage at the site of the present discharge canal system -- that the temperature will extend to 104°F. The Federal Water Pollution Control Administration study in no way identifies the absolute temperature at which it claims the damage occurs nor can it forecast that damage, if any, will occur at 95°. That study is irrelevant to the proposed plan of the Florida Power & Light. It leans heavily on the Hoover Foundation Report which claims that temperature in excess of 90°F will cause harm to the aquatic life.

The Hoover report, in my judgment, is an unwarranted speculation and not supported by realistic tests in the true operational situation. It relies on laboratory tests where man attempts to duplicate the environment.

Col. A. M. Davis

I feel compelled to make a statement on the Hoover report. This report was made by Dr. Gilbert Voss, a man from the Institute of Marine Sciences. In late 1967, he along with Dr. Idyll and Dr. Smith, Director of the Institute of Marine Sciences, made the following statement in applying for a grant or funds for a 3-year study of South Biscayne Bay, and I will quote:

"At the present time we know virtually nothing of the biological chemistry or hydrology of the South Biscayne Bay marine environment." Subsequent to that, this grant was not approved. Subsequent to that, a grant was made to cover a study of Biscayne Bay and the Turkey Point area to take 3 years. They started in July of 1968, and I presume will be finished in July of 1971. The principal person involved in this report is Dr. Richard Bader.

On February 24 and 25, 1969, 10 persons -- I believe all but one was a biologist -- met in the DuPont Plaza Hotel. This meeting was announced to the press several days in advance. The Florida Power & Light Company, who had at that time accumulated a great amount of information on the biology and the chemistry of water surrounding Turkey Point, volunteered to furnish this information for whatever it was worth.

Col. A. M. Davis

We were told that they did not want anything from us, and when I requested if a representative biologist could just sit in and listen, this also was denied. "Government in the Sunshine."

The report was made without study, review or even examination of the voluminous data and scientific reports that we had obtained. It was very obvious at the time and still is that this report was a pointed attack on the Florida Power & Light Company devoid of scientific objectivity.

The recommendations of the Hoover report were incorporated in a proposed ordinance for Dade County. It ws unanimously defeated by the Dade County Commission, one commissioner voting not to even receive it.

At a later date these recommendations were incorporated in two bills introduced in the Florida Legislature with these limits, which would have put the same limit on Silver Springs Run as Florida Bay, although their study said it was estuarine environment of Biscayne Bay, and the conservationists introduced a lot of these standards into these two bills before the legislature, and they both were killed.

The original Hoover report didn't have a bibliography. When the Dade County Pollution Board questioned this, a few months later one was made up. This seemed unusual to have the bibliogrphy filed to fit the report. Had this committee been interested in inshore and estuarine pollution, they could have written 10,000 pages on sewage, boats, drainage canals, land development and farming and other forms of pollution in Dade County. All of them much greater potential than thermal.

I do recognize that this report did add two paragraphs on biocides.

It has been implied that this report was by the Institute of Marine Sciences. It is interesting to note that Dr. F. Walton Smith, the Director of the Institute of Marine Sciences, stated this about the report: "That eight biologists from the institute did not represent the institute. The institute did not give any advice as to the selection or persons qualified for this particular task, and, therefore, accepts no responsibility for the report."

I am still quoting from Dr. Walton Smith. "This report is not based upon the known effects of increased ambient temperature upon the entire plant and planktonic community but upon the known effects of increased temperature upon specific biological activities of individual plants and animals."

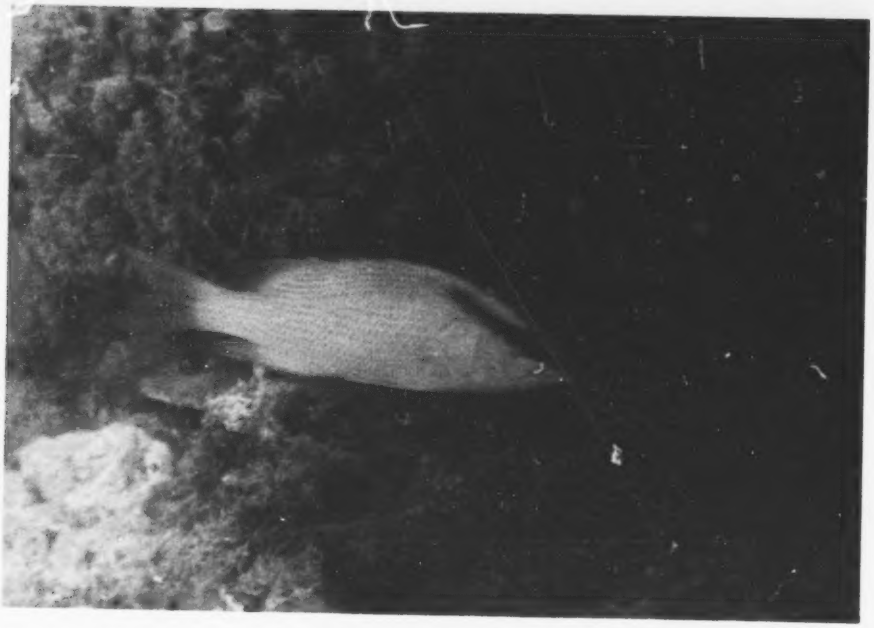
I'm still quoting. "It is my opinion that the committee made this report in such a way that it did not consider its reasons, nor give a bibliography, and other references to the source of that, and restricting its recommendation to the desirability of limits of ambient temperature for the Bay in general rather than an outfall, unless it is prepared to provide reliable hydrographic information on mixing and circulation, and greater flow of effluent from qualified persons."

The Federal WPCA is pointedly biased. As an example, it takes no look whatsoever at the benefits that can accrue from warm water being discharged in the winter months resulting in renewance of marine life.

I would like to offer this in evidence, pictures taken on 19 and 20 February in the area which I will point out, and these are the same photographs, and I wish every person in this room could go down there and look for themselves, and I invite all of you.

MR. STEIN: Col. Davis, we will accept these photographs without objection as exhibits.

COL. DAVIS: If you would like, I will hurriedly tell you what they are.



No. 1 is about 30 feet from the discharge. Here is Snapper, and you can see this area over in here.

That's No. 2.

Picture No. 3 is down about midway in the Grand Canal which is the main discharge canal. Temperatures here have reached 108°.

No. 4, I think you can see all of the fish that received protection in this area of the mouth of Grand Canal. That's picture No. 4.

No. 5 is a picture of what is called Little River. You can see the grass. I think that any biologist will say it is extremely healthy, and I also would like to say that the warm water going out at this point has been going out for over one year longer than this point here. And at one time this small place took all of the discharge, and you can find that year-round.

Point A is out in this area here. I don't know whether you can see that. You'd better correct me, Lee. I don't know what kind of grass that is. This over here is Thalassia, and this is Manatee grass. If you notice, A, B, C and D were taken at this discharge area.

Picture A.

Picture B.

Picture C.

Picture D.

COL. DAVIS: No one ever says anything about the advantages of thermal increases. Back on January 10 there were millions of fish killed in Biscayne Bay. No one bothered to report that. There were millions, and here are pictures of the dead fish in Biscayne Bay resulting from low temperatures.

MR. STEIN: Do you want these to be exhibits?

COL. DAVIS: Yes, sir.

MR. STEIN: Without objection these will be exhibits.

COL. DAVIS: So there are some advantages

MR. THOMAN: Let's go back. These pictures are not identified. In accepting them for evidence they should be identified.

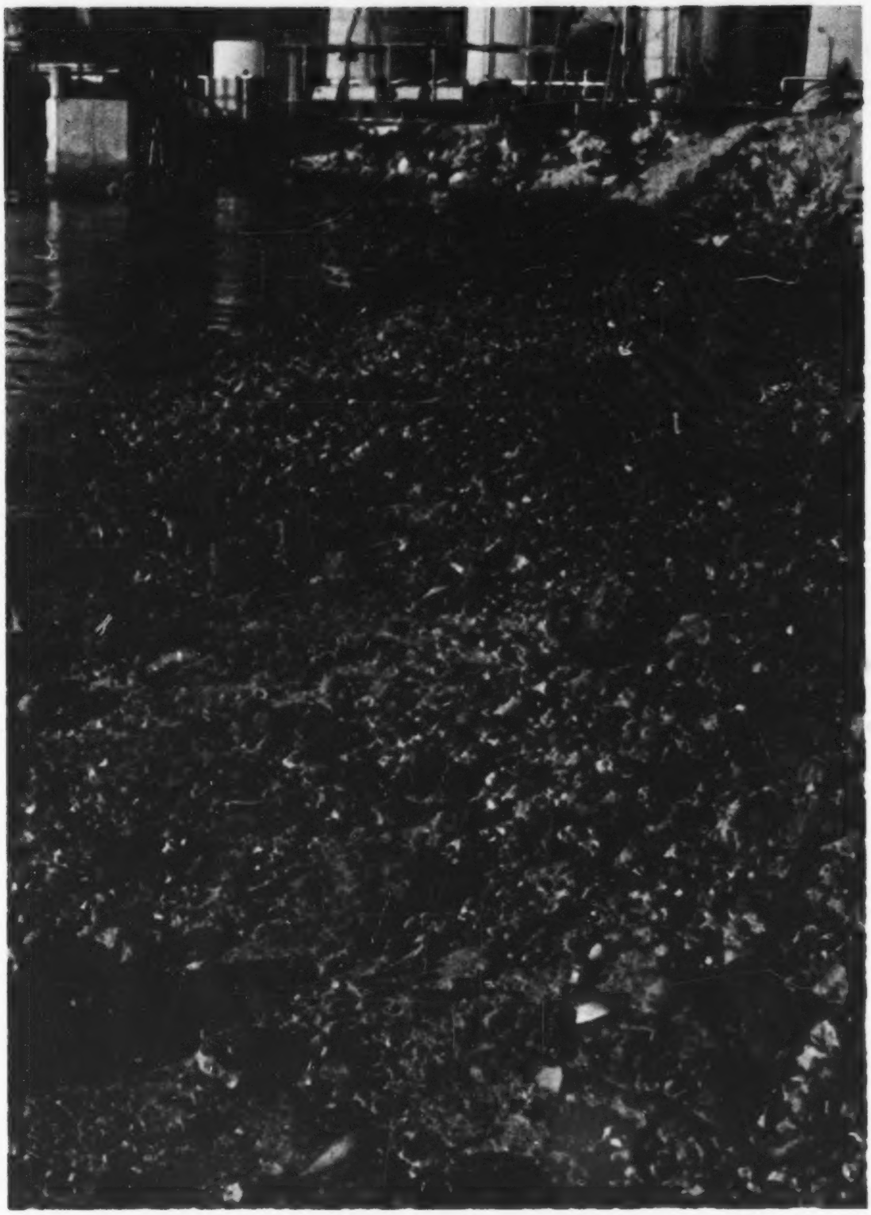
MR. STEIN: We are accepting them as part of the record. We will identify them as the dead fish found in January, which will be sufficient identification. This is a conference; not a hearing.

COL. DAVIS: In an area outside the heated effluent.

I knew you were my friend.

MR. STEIN: Yes, sir. Don't turn your head.

(The above-mentioned photos of dead fish follow.)



Col. A. M. Davis

COL. DAVIS: In addition to the foregoing, the report contains a significant number of factual errors. As an example, it concludes that Card Sound will be subjected to temperatures in excess of 95° at least 35 percent of this area 5 percent of the time.

This is totally inaccurate for two reasons: A discharge in excess of 95° is prohibited and the means of arriving at this temperature is through 150 percent dilution and not 100 percent, as the report quoted.

Additionally, it states when the two nuclear units go on, the unit will be 4 times over that presently discharged. A more accurate figure is certainly three.

On Page 14 the report states that the combined temperature rise when all units at Turkey Point are operating, under normal full load will be 14.2°F Under maximum power the temperature will rise 15.9°F.

Actually the combined rise when all units are operating at normal operation will be less than 14°, and under maximum power demands, which we have never run a power unit at 100 percent, it is just like your buying an automobile that will go 150 miles an hour. You just don't get in there and run it 150 miles per hour all the time.

Col. A. M. Davis

Our plants are designed for a percentage of the load, and with some slack that can take up a peak or can take care of something in an emergency.

The maximum, with all four running, if they ever did, would be 15°. The allegation that the biological degradation zone convers about 670 acres of Lower Biscayne Bay is without proof, and generally ignores Dr. Roessler and Zieman's report on thermal effects at the Turkey Point plant, which alleges 298. In effect, it is about 12 to 15 acres covered with silt. The Federal Water Pollution Control Administration report in ignoring its own study again reveals its biased study. Allegations that damage is due to the discharge of heated effluent is an unscientific conclusion. It does not take into account the impact of aquatic life caused by dredging material that was spilled out in the bay when the main canal was discharged.

I could possibly modify that because I believe that you changed your report to say something about the silt. If you did, my apologies.

On Page 39 the report infers that the

Col. A. M. Davis

productivity of Card Sound is equal to that of Lower Biscayne Bay, despite scientific investigation and study conducted by the University of Miami, which clearly states that Card Sound is less productive.

If this alleged fish kill did occur, why didn't someone notify Florida Power & Light? I found out about it by accident. A small note was given to me by a student, and I happened to be going to Atlanta and found out about it. Yet the newspapers were told, but no one told us.

Also why haven't you considered the salinity when at this particular time, on June 25 there was a tremendous amount of runoff offreshwater into this Grand Canal. This Grand Canal is the only drainage for thousands of acres east and west of the salt water barrier in that area, and part of it is farm land.

The report recommends that the National Technical Advisory Committee standards for estuary waters be applied at Turkey Point; namely, the monthly mean of the maximum daily temperature should not be raised more than 4° in the fall, winter and spring -- September through May -- or more than 1.5°F during summer, June through August.

Col. A. M. Davis

It ignores the fact that the committee's recommended criteria envisions a mixing zone outside of which these temperature standards would be applied.

Dr. Tarzwell awhile ago admitted that he failed to mention that when he was talking about the limits of 1½ and 4. He did not mention this. It is a misleading statement since a maximum temperature of this area reaches absolute value up to 99° approximately ½ mile east of the main discharge canal, and approximately 3/4 of a mile, as shown on Figure 16, when compared to the 86° shown on Page 27 for the mean maximum daily cooling water intake temperature.

We are talking about individual daily difference of some 13° over this. It is the absolute temperature that matters as to whether aquatic life is damaged, and this is a misleading statement. It only tends to further prove that the Board has no evidence whatsoever that damage occurred at 95°, since temperatures have been far in excess of such a value.

In summary -- we have only had this report a few days, and the comments are only preliminary. You can expect further detailed comments after we closely review this report.

Thank you very much.

MR. STEIN: Thank you, Col. Davis. We will now have comments and questions. First, I would like to make a comment which you can keep off the record.

(Discussion off the record.)

MR. STEIN: Are there any comments or questions?

MR. REED: I remember very clearly on leaving that meeting that we said to each other, "As a possibility, it certainly is worth examining with a great deal of care."

COL. DAVIS: Yes, sir, Mr. Reed, you were included when I mailed -- Mr. Starnes from our office appeared at our conference. I mailed you -- I have the mailing list, and I mailed you a copy. This included Dr. Dean's study.

MR. REED: Now, going on to Page 7, December 5-7 of 1968, I remember very clearly a discussion about the original cooling tower system. The original cooling tower system as proposed to me would expend into the air daily tons of salt, and I took exception to the fact that tons of salt would be allowable coming out of a cooling tower when the breeze is predominently a southeaster, to take the salt over the farm area of South Dade County.

I would like to make the point clear that that was in reference to a salt water cooling plant that emitted a vast quantity of salt per day.

COL. DAVIS: Yes, Mr. Reed, and we'll have an expert to testify on that.

MR. REED: No, I don't think it is necessary. The point is that there may be other forms of cooling towers. I certainly was not equipped to reject all cooling towers. Offhand, I rejected the one that was offered to me which emitted a vast amount of salt per day.

The permit system: There's no use to debate that in this conference. It is sufficient to say that I have been in the business a short time, as we all know in this room. I'm not a great expert. I was made a member of the original Florida Air and Water Pollution Board. When it became last July 1 the Department, I became its chairman. We have a very small staff. It is impossible for us to implement a program as far reaching as the current system in 60 days.

However, this should be clearly said by me that Florida Power & Light in no way violated the permit system because it has not been implemented, and that is nobody's fault; but at the same time it should not be used against them.

As for the mailing mentioned on Page 11 in the opening statement, I will be frank with you, sir. I think there is a considerable doubt in our department mind as to whether that was a formal application of a plan; and my staff reported to me that the proposition was worth studying and thinking about; and we have not responded. I am responsible for not responding, with apologies.

I am not capable of speaking about any error in the Federal report. We will refrain from doing so at this time until proper Federal officers who made the report have had a chance to respond.

However, I do think that we heard enough this mroning from qualified experts to know that we have a potential problem, a very serious problem, and I can only agree with the -- I can agree not only with the thermal discharge but also a velocity discharge.

We also heard a great deal about the difference in finding a great deal of biota in the canal in the wintertime on a very cold day, and finding damage from the bay on a very hot day. It is not going to do me any good, representing the State of Florida, to call people names and I'm not getting into that posture.

I am here representing the State, recognizing that we have here a mutual problem, and I am here to find a solution to that problem; and that concludes my remarks.

MR. STEIN: Thank you, Mr. Reed.

Do you want to comment on that in any way, Col. Davis?

COL. DAVIS: Yes, I would. The Florida Power & Light has, is and will always be willing to cooperate with any Federal agency, public body or the public at any time. We will sit down with you tonight, tomorrow, anytime that you desire. I have gone through many of these hearings with Mr. Reed on setting standards, and we both know what they are, and how difficult they are, but we are certainly willing.

MR. THOMAN: Col. Davis, I rather resent the statements that you have made in your prepared statement, and I would certainly like to have a copy of your last remarks, if I may, please, in which you called attention to certain things in our report.

I believe that I recall correctly, along with Mr. Reed, that when we met with you and Mr. Smith in

October, I believe, of 1968, you described it -- you said "We would be most happy to consider it." I don't believe anyone indicated any approbation of this method of dissipating the heat at that time.

I further call to your attention that when you sent a letter to Mr. Howard Zeller, of my office, dated June 30, 1969, a 7 page letter outlining provisions of that proposal, your last paragraph says, and I quote:

"Your concurrence in this plan and necessary support in obtaining required permits is earnestly requested."

Sir, we don't grant permits, and we don't concur in your plan. There is no authority in the Federal law that was under consideration at that time for doing anything of that type. That's No. 2.

COL. DAVIS: Do you want me to answer?

MR. THOMAN: No, I don't. I want to go on just a minute.

In that same letter of June 30, 1969, and I quote:

"The extended canal with 100 percent dilution represents the best and the most practical means of handling the cooling water."

Col. A. M. Davis

At no time in any official communication with the Florida Power & Light have we ever been advised that this plan included 150 percent. We want to get that part of the record straight so that the part of our report which you so roundly criticized, and unjustly was based on the best information that you had furnished to us.

I further submit that -- and I do not have my dates here -- your chronology of events prepared by Mr. Kincaid, which you submitted with your statement, might have a few additions to it, particularly one. I believe, around February 2, 1968, where at my request the Florida Power & Light Company met with a wide number of Federal agencies, and in which I publicly stated that there had to be some sort of heat dissipation at Turkey Point.

I again made this statement, I believe, in May of that year, which is also not in your chronology, when the staff of the Senate Subcommittee on Air and Water Pollution Control made a visit to your plant a day before a public hearing conducted by Senator Muskie. I don't have the dates on that.

Chick, I'm real sorry. I think there are some things in here that go part way. They don't go all the way; and that's it.

COL. DAVIS: We will be glad to add anything that is missing after we have researched our files. We'll be glad to do it.

Mr. Thoman, as far as permits go, we asked your assistance. We realize that we had to have a permit from the Corps of Engineers, and we required your assistance in that.

MR. THOMAN: In those cases then you file a formal application for a permit, and will take formal action. The same as this formal action is being taken at the request of the Governor of the State of Florida, Claude Kirk.

COL. DAVIS: As far as 150 percent, that was presented with members of your organization present, and they received a copy.

MR. THOMAN: Sir, I have heard 150; I have heard 200. I believe that someone reported to me that you had offered -- you would offer to go to any kind of dilution.

COL. DAVIS: No, sir.

MR. THOMAN: All our people can work on is the official record, and that is in the record, sir.

MR.STEIN: I think we have dealt with a lot of industries throughout the country, and this is reminiscent to me of the kind of conferences we used to have maybe 10, 15 or 20 years ago. I'm not sure -- you can go on because we are not going to cut you off -- but this question of chronology, who said what, or who sent a letter to whom, or who was at what meeting, I don't know where that leads us with the problem that we have facing us.

Now, if you think it is pertinent, we will put it in, and we can go through it. I am sure if we ever have to go to a hearing where something is under oath or court action, and then things do become pertinent, we'll have it.

But I suggest that we have a substantive problem facing us now, and what I think the issue should be is to try to see if together we can work out this problem. The difficulties that I have with the chronology is when you get through and lambast fifty guys, you have fifty people in the army lined up against you.

Col. A. M. Davis

I just have a few points with you, and I hope that they will be substantive.

On Page 22 in your statement you say that 95° -- and I think you remember this well because I think you have said this many times before. That you have the only numerical criteria presently in existence, right? 95°?

COL. DAVIS: Sir?

MR. STEIN: Page 22.

COL. DAVIS: The only numerical?

MR. STEIN: Yes.

COL. DAVIS: Yes, sir.

MR. STEIN: Now, again, let me point out we are dealing with another kind of criteria here. This is the criteria that was put out by the National Technical Advisory Committee. This is 1½° rise in the summer, and about a 4° rise in the winter, which would take care presumably of adding a little more heat in the winter and in helping us out, because I don't think that anyone said that a minimum amount of heat is visible. This came out in June of 1967, and they put it out April 1, 1968.

So the issue, it seems to me here that we have -- and this is a substantive one that both we and the industry and the State and Dade County, and what-have-you have to deal with -- are we going to deal with the criteria, say, of 95° or however that was arrived at? Are we going to deal with the Federal suggestion? Are we going to deal with anything in between? This seems to be the issue that is facing us today.

COL. DAVIS: Yes, Mr. Stein, I am familiar with it. However, I think that you will agree that many States can raise the temperature by 10 percent or some up to 10°. I have seen some that are 95°, I have seen some 98° which were approved by the Federal Government. As an example, there are several different --

MR. STEIN: Col. Davis, you know, I have another hat, and possibly because of this temperature, last October I got the standard set into operation. I did find certain anomalies in the States. One or two States have a 10° rise, and some of the other States asked me if that State has 10°, why don't you give us 10°? I said, "Just because some of them made a mistake in one State, I'm not perpetuating it." The one thing we have to recognize is when we make a mistake in the criteria, all of the standards -- and I am not just talking about temperature; I'm talking about toxic material, metals, anything that we talk about, the poor souls, if we have souls, that don't know anything about it, are the fish. If we make a mistake, they die.

The point is, just because there have been some things in the past, we are trying to do our level best to come up now with something that will protect the environment in this area.

Again, I allude to what I heard this morning, and I wasn't really fully aware of that. You have a tremendously high quality water here, and it would be a shame to let anything happen to it.

So I think that if we can approach it at that level -- and, by the way, that is what I'm doing with all the States.

Let's go off the record a minute.

(Discussion off the record.)

MR. STEIN: Let's go back on the record.

So I do think that what we are going to do here is try to work out a standard that is going to protect Biscayne Bay and Card Sound. I don't think there is any disagreement with that, is there?

COL. DAVIS: I fully agree with you, Mr. Stein, that there has to be a standard that protects. I fully agree. My point was, and still is, that I am trying to get a powerplant designed. I do not argue with you the principle that you make. I do not argue that. We have stated that we will do everything we can.

MR. STEIN: I understand that. Again, I don't want to push us too far on the philosophical issue. But it seems to me, sir, what I could consider a good standard for a powerplant or any kind of plant that was going to take in and discharge 2 3/4 billion gallons of water a day; is to put that water out in the condition that you took it in, and that includes the temperature. I don't think there is any vested right to raise water temperature or change any other water quality, particularly when you plan on taking such large amounts.

Let me get back to another point because this is fundamental, and I think we have to work at it carefully. I refer to a note that I took during your remarks before you began reading, the statement when you said this -- something very close to it -- "We wish to state that we have built the canal on our own land, and we paid for it."

Col. A. M. Davis

No one is denying that, but the notion that you can do anything that you want on your own property that you have paid for is precisely the reason that we are here. I think we have to recognize, and this is the reason we come to you and say, "Even though you do this, you have a public responsibility of the public waters when you get there."

This is no answer that it is your own property. You were down in those Mobile and Gulf Bay cases where one of the companies bought all the land around the river, and the paper company bought all the land around the river and was using that to discharge its waste.

Twenty years ago, or perhaps even ten years ago that might have been all right. But what I am here to say, sir, is that if we get into that kind of an argument, I think there may be a fundamental clash, and this should be avoided. Now, I don't think that we in administering the Federal law can give -- you have a responsibility even though it is your property.

Now, this one last point. Why are you building that canal to Card Sound? Why don't you discharge that water into Biscayne Bay?

COL. DAVIS: We would have recirculation and an accumulative buildup.

MR. STEIN: In other words, you think you may have damages in Biscayne Bay? Don't you have damages in Biscayne Bay?

COL. DAVIS: These people say so.

MR. STEIN: Now, the question that I have --

MR. THOMAN: Explain recirculation.

MR. STEIN: I think that I know about that. I would appreciate it if you didn't interrupt. We will get to that later.

You said that there were indications that there were damages; and I don't doubt the expenditures of all of those funds to go to Card Sound; but maybe Biscayne Bay would be appropriate. I have here a copy of a meeting of November 7, 1967, of the Florida Air and Water Pollution Control Commission, which met in the Cabinet Room of the Governor's office starting at 9:00 a.m., Tuesday, and you were evidently present where you said: Col. Davis said, and I quote:

"If there is any scientific proof that there is any degradation of these waters by increased temperatures after reasonable mixing, the Florida Power

& light company would take corrective action to the satisfaction of the commission."

COL. DAVIS: You're exactly right, and we will.

MR. STEIN: All right. Now, the point is, let's make this judgment. If the conferees (the commission representatives here) agree that there is proof that there has been scientific degradation by increased temperatures after reasonable mixing in Biscayne Bay -- and you have tried that already -- and if we come up with corrective action that satisfies the commission and they put it forward, I assume you are going to take it and be ready to accept it?

COL. DAVIS: We have to abide by any law.

MR. STEIN: I don't think we have any problems. I believe we are in full agreement. I don't find any problem here at all.

Are there any further questions?

COL. DAVIS: Were we going to recess?

MR. STEIN: I understand that some of the people that you called did not appear because they had a previous commitment and left. Again, let me state this, unless there is a violent objection, my experience has been that after 5 o'clock the reporter begins straining. The record begins to deteriorate; all the participants begin getting a little testy; and you say things that you regret the next day. The trouble with that is, if you have the record, you're stuck with it.

I would suggest if you want to make a short statement to go ahead, but I would like to recess until tomorrow.

COL. DAVIS: Whatever is suitable to you and the audience. We will be willing to start any time that you say in the morning.

MR. STEIN: Again, I say this on the basis of past experience, the time we should start is 9:30. I have tried starting at 9:00 and 8:00 but you never do it. Even today we were late. I usually start on time. I also have a notion there's a psychological advantage once you start on time you go through. Once we say we are going to start at 9:00 and start at 9:30, then delays start building up; so we will recess until 9:30 tomorrow morning.

(Whereupon the conference adjourned at 5:20 p.m.)

☆ U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 401-137